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MAN THE CONQUEROR

MAN'S TRAVELS IN EXPERIENCE

BY

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NOTES TO TEACHERS

There are several obvious difficulties to be faced in writing a book for Matriculation students. It must be sufficiently advanced in idiom and language to afford a means of linguistic study, and yet must be easy enough not to stifle interest. Moreover, if it is to encourage something more than a superficial interest in literature, it must arouse curiosity, and a desire to build for oneself on the foundations which it provides. Above all, it must make demands both upon teacher and student, or it will leave little lasting impression.

With these difficulties in mind I have tried to write these chapters as simply as possible, and when I have been obliged to use a difficult or unusual word, I have repeated it frequently, in order to familiarize its use and meaning. *The brief notes* are not intended in the least as a substitute for a dictionary, and have been employed mainly to provide additional information, and to encourage further enquiry. While they may have some value, therefore, they *cannot take the place of class explanation and oral work.*

The book is designed to encourage an interest in certain aspects of History not usually dealt with in a Matriculation course, and singularly absent from most History Text-books. It is, so far as possible, up-to-date in its information, and should help to develop an understanding of the world of invention and progress and social development, which cannot fail to be of interest to the normal student. Above all, it is hoped that it may widen the horizon, and broaden the basis of the Matriculation course, by stimulating an interest in the modern world, and its social and economic problems, which is perhaps one of the main aims of Education.

But I canot disguise from the Teacher that it will make demands upon his patience and leisure. The information which these chapters contain will not be fruitful unless it is supplemented by illustrations and explanation in the classroom ; and these will depend entirely upon the Teacher's own knowledge and preparation. If this little book is successful in stimulating original enquiry and curiosity, in encouraging frequent reference to dictionary and encyclopaedia, and in adding new interest to the study of English, it will have achieved its purpose. I am fully conscious of its many shortcomings ; but as a Teacher I commend it to my fellow-Teachers, in the hope that it may provide both interest and instructions.

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CHAPTER I

THE SCIENTIFIC SPIRIT

The story of the appearance of life on the earth is a long and interesting one. Before man appeared other forms of life existed already. His life was full of difficulties and dangers. Man, the conqueror, gradually overcame these dangers. The present position is that animals—even tigers and leopards—slink away into the jungle at his approach. He has made use of the forces of nature, and overcome its terrors. Darkness and lightning, thunder and earthquake, volcano and the storm at sea, overwhelm him no longer. Night comes, and he turns it into day. Thunder and earthquake pass away leaving destruction behind. But he has energy and faith to build again. The only creature he is afraid of is himself—because he can do both good and evil.

It has taken him many ages to reach this position. Picture to yourself a world without houses, without roads, without even mud huts, fields and wells ; nothing but swamps, alive with huge crocodiles and other fearful animals, larger and more terrible than any known to us to-day. There are everywhere dark thick forests with only the tracks of terrible monsters breaking their way through the jungle, feeding on the leaves of high trees, or pursuing animals not quite as terrible as themselves.

Into this strange world first appeared Man; not alone, but in bands. He was too afraid to go about the world alone. His only safety lay in numbers. He had no protection against heat and cold except the interior of a cave. He had no clothes, no weapons; but he had what no other animal had ever had—the capacity to think, and the capacity to speak out his thoughts. Reason and speech he has had from the very beginning though not in their developed form as he has them to-day. How he came to have them at all is still *an unsolved mystery*. They form two of God's greatest gifts to His world.

From the very first, Man was a fighter. He had to be a fighter, for the world in which he lived was not an easy place for him. It was a world in which animal preyed upon animal, a world which was full of disease, to which Man, who was physically the weakest of all the animals would fall the easiest victim. But it was in this life of constant fear that he laid the foundations of his own greatness. The more he was afraid of his enemies, the more he thought out the means of escaping from them, or defeating them.

It has been well said that "Unity is Strength." The earliest men thought of combining together to beat back their enemies. Primitive men made for themselves rough clubs of wood or stone to defend themselves against enemies whom nature provided with sharp claws, and powerful arms; we have developed that rough club into the deadly weapons of modern warfare. The more Man has tried to do, the more he has achieved, though his achievement is not yet finished. His life on this earth has been one long struggle against great difficulties.

It is not hard to picture these difficulties with which Man had to contend in the beginning. He had to learn things which seem simple and ordinary to us. He had no knowledge of fire, and so could not cook his food or even keep himself warm. He had no clothes to protect him from rain and cold. Only the shelter of a damp cave served him as a home—while the beasts of the forest filled his heart with fear. His food he had to find for himself either by hunting, or by searching for nuts and berries that he could eat. The night was terrible with the fears of darkness; the day brought no relief from fear, and the constant dread of unknown powers. There was little idea of a "home" and men only joined together from the needs of self-defence. Next to the terrors of the forest, man's greatest fear was his fellow-man. Such a picture of a fireless, comfortless, fearful world is an amazing contrast to our civilization of to-day.

But, to turn to the next stage of Man's progress, imagine the joy and surprise of the first man who rubbed together by accident two pieces of wood or flint and produced a spark. Perhaps he burnt his fingers or even died of shock. He was the first scientist, and the first of many great engineers and inventors. Yet it is probable that he was more afraid than proud of discovery. When he had first made fire, how difficult it was to put it out, or to control it!

The reason for all scientific experiment is a search for Truth. Scientists do not care for the consequences and are careless of reward; their one and only aim is to establish the Truth. And so men have explored the lowest depths of the sea and scaled the highest mountains; they have used the power of the waves and the wind; they have travelled into unknown lands and tried experiments upon their own bodies; they have held their lives cheap in comparison with the discovery of new truths. This has been the greatest adventure of Man's history; to it we owe all the comforts and conveniences and inventions of our modern world.

It is true, of course, that originally man started to inquire into things out of mere curiosity. He had eyes to see, and a rapidly developing mind urging him to understand what he saw. In the beginning we can look upon Man as a child. The older he grows, the more he investigates the many unfamiliar things that make up his world. Since he has no one to teach him, he is compelled to educate himself. For example, he quickly makes the discovery that very hot or very cold things are painful to the touch. In many cases he still gets the best education through his own efforts.

This desire to know things for the sake of knowing them is the highest ideal of science. We have seen that scientists are partly led to make their important discoveries by a desire to reduce the sufferings of mankind, and to increase its comfort. But that is true only in an indirect way. The greatest of our scientists are concerned only with the pursuit of Truth. To what else it may lead them does not occupy their thoughts for very long. It is very easy to forget our great debt to the scientists of the past. We so easily concentrate on what seem to be the wonderful discoveries of the present, forgetting altogether the work of men, known and unknown, who have made these discoveries possible. Our knowledge of the world in which we live is derived from the adventurous journeys of countless explorers and pioneers; even now there are large areas of Africa and South America entirely unknown. Whenever we travel by train or drive in a lorry, even when we use a tonga or a bullock cart, we are making use of inventions and discoveries all of which seemed to be wonderful at the time when they were first made. The food we eat, and the implements we use with which to cook and eat it, were all important inventions at first. Our clothes did not suddenly reach their present stage, but they have undergone centuries of change and development.

In health we depend upon exercise and games; in sickness we rely upon medicine and medical skill; but in both cases we are the heirs of the past. Our forms of government and social organization—from the largest modern city to the simplest mud-hut village—are derived from the past. Our roads and canals, our letters and newspapers, our telegrams and cables and wireless have been handed down to us. For them we are in debt to the past, as others in their turn will be in debt to us. In fact we are everywhere faced with the greatness of Man's achievement, into the enjoyment of which we have entered.

Not always, it is true, have these achievements been entirely unselfish. Men will strive from motives of religion or of patriotism, or even from selfishness. But a love of knowledge, a burning desire for the betterment and improvement of humanity, an adventurous searching after Truth, form the road along which are marked the milestones of Man's achievement. Nature is like a watchful enemy that never leaves a mistake unpunished. Her laws have no exception : she never goes to sleep and therefore she cannot be taken by surprise. Man has conquered her by showing his superiority in overcoming the obstacles put in his way. In order to achieve his end he must see clearly ; his hand must neither hesitate nor fail ; his patience must be endless, and above all he must be humble.

One of the best examples of these heroic efforts to increase human knowledge is to be found in the many expeditions that have been led into unknown parts of the world. The discovery of the interior of the five continents, by one explorer after another, voyages into the South Seas, journeys across deserts, expeditions into the Arctic and Antarctic, and exploration of mountain ranges, are splendid examples of human endeavour under difficult conditions. Sometimes, it is true, religious enthusiasm or a desire to extend the power of their own country may spur the adventures of explorers; but in general it is a love of knowledge, and a desire to know the unknown, which has driven men into the loneliest and most difficult corners of the earth.

Among the most famous of such explorers are *Marco Polo, Drake, Livingstone, and Amundsen;* and one of the most heroic of these expeditions was led by Capt. Scott to the South Pole in 1912. Scott and his four companions pulled their *sledges* alone for 147 miles in the surrounding wilderness of snow. They carried their own provisions with them. They deposited these provisions in pits in the snow as they went along, so that they might use them on the return journey. The party reached the Pole on the 18th January, 1912, but the march had been attended with so many difficulties, and so much time had been wasted in overcoming them, that unfavourable conditions set in soon after they had begun the return march.

One member after another collapsed from starvation or from fatigue. But all of them showed the same cheerfulness, the same thoughtfulness for the safety of others, and faith in the task they had undertaken. Most heroic of all was the voluntary death of Captain Oates, who "disappeared" so that other members of the party might not fail through him. He suffered severely from frostbite, and his companions had to go slower to help him on. When Captain Oates felt that death was upon him, and that by his illness he was putting in danger the life of others he said to Scott: "I am just going outside, and I may be some time." With these brave words he disappeared into the blizzard that was blowing. He went forward to meet his end, so that the others may continue their return journey. But even his voluntary death did not save this gallant band of scientists. They marched on and on till 21st march, when the party, now reduced to three, was forced to camp on account of another blizzard. They were only eleven miles from a depot where they had deposited at least a ton of provisions. They had very little food with them: hardly enough for two days. The blizzard continued to blow for four days; they were prevented from coming out, and they perished in the snow in their tents. Their remains, together with the diary of Captain Scott, were not discovered till a year afterwards! It was only then that the world knew of their suffering, their fight against the forces of nature, and their triumph over the wilderness of snow.

The death of Captain Scott and his brave companions is only one of the many instances that show the spirit in which men of science pursue knowledge. In recent times the expedition that have been organised for the conquest of Mt. Everest and Nanga Parbat or the journeys into the *Stratosphere*, regardless of expense or suffering, show the same determination to explore the unknown at all costs.

The virtues of a man of science are also well illustrated in *Herschel*, the great English astronomer. He was constructing a large telescope which was fitted with a seven-foot mirror, which Herschel had to polish with his own hand. He discovered that the best polish could be obtained if he continued without stopping till the final surface was reached. He continued for sixteen hours without taking off his hand for even a second, while his sister put food into his mouth to keep up his strength.

And when this telescope was finished, he undertook the almost impossible task of surveying the whole of the sky visible from his observatory. He observed the whole night through ; he examined the sky inch by inch ; he let every star pass through the field of his telescope three times, so that nothing could escape his watchful eye. He continued this task for five years, and very nearly succeeded in achieving what he had set out to do.

It is men ef this type, men like Herschel and Scott, who have made the twentieth century the wonderful age that it is. They work quietly in their laboratories, or go out into the unknown, and people know little about them till they have done something that the world chooses to call wonderful. But to the student of science himself, whether he is a beginner or a specialist, his laboratory is his field of battle; all his results are wonderful; all his efforts are directed against the greatest enemy of Man—Ignorance.

CHAPTER II

THE CONQUEST OF DISTANCE ON LAND

One of the earliest needs of Man must have been to carry things. Having killed a large animal or collected a quantity of roots or fire-wood, he was faced with the problem of carrying them to a place of safety. The thick undergrowth offered every possible difficulty. There were no sign-posts to direct his way and nothing to help him except his own skill. Yet once stored safely in his cave, he could enjoy the pride of possession, and the knowledge that he had overcome the earliest problems of distance and transport.

The use of animals as beasts of burden came quite late in his history. For, apart form the fact that it took a long while to domesticate these animals, the difficulties of carrying things across country without even a path, or through the thick jungle, must have been very great indeed. The earliest form of transport therefore was a load carried by Man himself upon his head or back. Still to-day in mountains where even a mule or *yak* cannot go, Man is the strongest and safest beast of burden. How many homes in India and the East still depend on this capacity of Man to carry his own burdens ! But it was not long before the earliest "cart" was developed. Probably it took the form of a rough sledge, covered with dry branches or skins, pulled by Man and his family. This greatly increased the loads which could be carried, and encouraged the cutting of paths through the jungle leading to his home. But still the *motive power* was his own; he had not yet established his mastery over any of the animals of the jungle.

That came later. History tells us that the dog and the horse were the first animals to be used in the service of man. It is not difficult to picture a dog creeping from the darkness of the forest to the warmth of a fire burning in the mouth of a cave, and learning to expect from Man bones and welcome scraps of food. The horse does not seem to have been much used for carrying or pulling loads. The man on horse-back has always been the sign of the Man of Power—the Leader in Peace and War. But at any rate the ox soon took the place of both the dog and the horse. In many countries it is still the only means of transport for heavy goods, and it has always been the patient helpful friend of Man.

The problem of trasport, and of Man's attempt to overcome distance, divides itself into two parts ; the invention of a carriage and the making of roads on the one hand, and the power to move the carriage on the other. It has taken centuries of toil to make improvements in them both ; and the ox did not become the greatest of Man's allies, until Man had invented wheels. From the sledge to the roller, and from the roller to the wheel was a long process. Indeed only in very recent times was it discovered that wheels with spokes in them are lighter and can travel faster than discs of solid wood with an axle driven in. But the process, though a slow one, was continuous; and the earliest "cart" was the direct ancestor of the modern train and car

We become so used to things about us that we take their existence for granted. And yet there are still millions of people in the world to-day who have never seen a railway train or driven in a motor-car. Not very long ago when a man went on a long journey or a pilgrimage, he parted from his people as if he never expected to return. Yet to-day we undertake a journey of a hundred miles with far less anxiety than the earliest man who walked a hundred yards from the cave.

During the last hundred years in fact, progress in the means of transport has been more rapid than in any other direction. A hundred years ago, the journey from London to Edinburgh by coach involved a series of changes and all the discomfort and anxiety of four or five days upon the road; in 1937 the same journey is covered by train in six hours. The peasant toiling beside his bullock-cart, at a slow two or three miles an hour, and *John Cobb* racing along at 368 miles an hour, present a world of contrast not easily understood. And yet in less than a century this has come about, so simply and naturally, that we fail to appreciate fully the long years of failure and early discouragement.

Not have all the difficulties been overcome. In the twentieth century there is still a widespread distrust of travelling by aeroplane; those who use the air as a normal method of transport are still regarded as pioneers. And yet about seventy years ago, exactly the same kind of opposition to the construction of railways, caused many useful schemes to be given up. The first, if not the greatest, of the English locomotive engineers, the little-known *Richard Trevithick*, was so disheartened that he left his country, and went to South Africa. He did not return till George Stephenson, who is generally wrongly supposed to have invented the railway engine, had overcome some of the popular mistrust, through successful runs with his first engine, called "Locomotion."

The first man to show that it was possible to move a carriage by means of its own power was a Frenchman named Joseph Cugnot. In 1769 he constructed a three-wheeled carriage with a big copper boiler for the generation of steam. In 1770 it was tried in the streets of Paris in the presence of a crowd of spectators. It carried four passengers and travelled by its own power at a comfortable pace of three miles an hour! The whole of Paris was astonished by this machine which moved without the help of man or beast. As a reward, and as a result of their admiration, poor Cugnot received not thanks but mocking laughter. The people saw in him a man who led commerce with the devil, a man who went against the laws of God and man. They waited for an excuse, and when he ran his steam-carriage into a wall, they put him in prison, and felt satisfied that they had saved France from the mad tricks of a very dangerous man.

The faith and sacrifice of these pioneers of science are rewarded only in the end. They carry in their hand the torch of knowledge, which is handed to the next man before he falls a victim to the ignorance of the people. The work of Cugnot or Trevithick was not wasted. The faith of these engineers in the powers of steam was stronger than the mistrust and laughter of the men of their own day. It remained for George Stephenson to develop their ideas in practice.

Stephenson was not a rich man; far from it. He was one of the poorest boys who ever achieved fame and success. He was born on the 9th June, 1781; his father was a poor miner who could not even send his son to school. As George grew up, he was sent out to look after a neighbour's cows and earn his share of the family's small income. By and by he was taken into the coal-mine where his father worked, and here he was fascinated by the steam engines that carried the loads up and down the shaft of the mine. He soon learnt to understand their working; but his eager mind sought to discover the principle by which they worked.

His desire to know more about these engines led him on to reading and writing. He had to start with the alphabet, because he had never been to school, even for a day. All his leisure he spent in the study of books, or in making models of steam-engines, that would move along a track. He showed such cleverness in the management of machinery, that his employer put him in charge of all the machines in the mine. He obtained his master's permission to construct an engine to carry loads from one part of the mine to another. The permission was granted unwillingly, because people were afraid that a moving steam-engine would blow up.

Stephenson soon showed how false these fears were. With the help of the engines that he built, his employer was able to do without a hundred horses that had been employed to pull the trucks of coal in the mine. When other mine owners heard of the success of Stephenson's engines, they shook their heads wisely, and said that such mad schemes were bound to fail and would surely end in destruction.

But here and there an adventurous owner came to see Stephenson's engines at work.

Among them was one who was building a "rail-road" about fifty miles long, for coaches to be drawn by horses. He was so struck with the possibilities of the steam-engine as a means of locomotion that he ordered Stephenson to build an engine for him. It was built, and it successfully carried coaches and passengers over the track.

But on the whole Stephenson was no more lucky than Cugnot. People laughed at him. One of the newspapers wrote : "We should as soon expect people to allow themselves to be fired off from a rocket, as trust themselves to the mercy of such a machine, going at such a rate." People in those days believed that moving any faster than ten miles an hour would send such a rush of blood to the head that their blood vessels would burst ! The earliest trains were compelled by law to be preceded by a man carrying a red flag as a warning to the public !

Recent improvements in the speed, the strength, and the shape of steam-engines have been made possible by the development of the finest machinery. The growing needs of all countries in trade at home and abroad have urged railwaymen and engineers to build better engines year after year. The railways in Europe and the United States of America, in Africa in India and in Canada are marvels of modern organization. The Canadian Pacific Railway is not only one of the longest in the world, but it claims also to furnish a link between East and West. It joins Liverpool with Yokohama. It carries the trade of the Atlantic across to the Pacific and back.

But in spite of the importance of railways, the Railway Age is past. The desire to overcome distance has taken hold of the modern mind. Side by side with railways has grown another method of travelling which rapidly threatens to take their place. Beginning with an invention on two wheels, propelled by the rider, in the closing years of the nineteenth century, we have rapidly developed the modern bicycle, the motor-bicycle and the motor-car. These we owe to the principle of the internal combustion engine which in turn depends upon the manufacture of petrol and countless other mechanical inventions. Already the railway and the motor-car are serious rivals as carriers of the world's trade on land; and although the advantage for weight and long distances remains with the railway, considerations of economy, convenience and comfort are heavily on the side of road transport.

As it was with railways, the development of road transport has not been without its serious difficulties. In the East it is hard to realize them. But the earliest stages of travelling by road in England furnish a thrilling story of hardship and adventure. While, even as far back as the time of the Moghuls, caravan after caravan of horses, and camels, and horsedriven carriages passed along the Grand Trunk Road from Peshawar to Calcutta, rolling along smoothly over a good road, English traffic struggled on through country lanes that were knee-deep in mud. The dry, hard soil of India provides natural roads that ensure a good surface most of the year round. It is only in the rains that country roads become impassable. But England is a very wet country : her soil is very soft, and it is only within quite recent times that her system of pucca roads has been developed.

For centuries, in England, men and goods had been carried on horseback. Since the days of the *Romans* (who were perhaps the finest road engineers ever known, better in many ways even then engineers of the present day) Englishmen had not known the luxury of travelling. Even rich people could not move from one place to another with speed or comfort. A carriage drawn by four or even six horses moved sometimes no faster than a mile-and-a-half an hour.

As we are told by one writer after another, English roads were simply a series of pits filled with soft mud, sometimes two to three feet deep. If a carriage once became struck, it could only be lifted out by men ; horses could not drag it out.

No improvement in travelling was thus possible till the roads were first improved. The credit for making good pucca roads possible went to two British road engineers, Macadam and Telford. From their work it has been comparatively easy to develop the splendid main roads of the twentieth century. The road being thus provided, the development of mechanical vehicles soon followed. There are many people still living in England and America, who can remember the earliest motor-cars, which exposed the travellers to wind and rain and were liable to stop on every hill. Only thirty-five years ago a speed of twenty miles an hour on the road was considered to be extraordinary ; those who risked the perils and discomforts of motor-cars were regarded as pioneers ; and the appearance of the earliest models is still sufficient to make us smile.

But good roads and mechanical efficiency alone are not enough for faster travel. The earliest form of the bicycle was called the "Bone-Shaker," since it bumped along on its steel or wooden tyres and fixed wheels. It was not till the discovery of ball-bearings and rubber tyres, that the development of modern cars was really made possible.

In its natural state rubber becomes soft and sticky under the influence of heat, and hard under the influence of cold ; therefore in only that state, it would not be of much use. An American, Charles Goodyear, discovered that

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rubber could be hardened, so that it would not be affected by temperature, by adding to it sulphur, which had been melted by heat. The compound thus formed is called 'vulcanite'; and vulcanite retains its firm elastic form under all ordinary temperatures. By varying the proportion of sulphur, vulcanite can be made as hard as the substance of which combs and fountain pens (and many other things) are made; or it can be made as soft as the air tube of a bicycle. Not the least among the marvels of modern invention, has been the production of rubber tyres, capable of withstanding the terrific strain and friction of travelling at over 300 miles an hour.

The discovery of vulcanite and the invention of the earliest motor-car took place about the same time. The wheels of bicycles and motor-cars were then fitted with what were known as "solid tyres." Tongas and other horse-driven carriages still have a band of rubber passing round the wheel to give them smooth motion. But with the weight and speed of a modern car, solid rubber tyres have been abandoned. It was a happy thought of Mr. J. B. Dunlop of Dublin that has given us the comfort of an air-filled tyre. He decided to use an outer tyre of solid rubber—but he invented an air-filled rubber tube which acts as a cushion between the cover and the rim of the wheel. The tyre saves the delicate tube from injury, and a valve keeps the air in the tube at the correct pressure.

Still one more serious problem remained. A heavy wheel revolving many hundred times in a minute, causes friction between itself and the axle on which it revolves ; and this friction was so great that even by constant oiling the axle could not be kept cool. This is still shown by the presence of the mechanics who test all the wheels of a train after a long run, to discover any sign of over-heating. But it was discovered that series of small steel balls arranged round the axle, in a bath of oil, and moving with the wheel, reduces the friction to a minimum. And this principle has now been applied, not only to bicycles and cars, but to many other moving parts of machines, such as electric fans.

Another point in connection with land transport must be mentioned. Every road or railway track is bound at some time or other in its course to meet with natural obstacles, such as rivers or mountains ; and no small credit for Man's conquest of distance on land must be awarded to those who have bridged the rivers and tunnelled the mountains. No country affords such an excellent example of the necessity for constant and difficult bridging than India where river floods can stop all transport. Again, the mountain railways of India illustrate Man's skill when faced with obstacles that he can neither avoid nor go round.

CHAPTER III

THE CONQUEST OF DISTANCE ON WATER

From the very earliest time Man has given more attention to transport on water, than to transport on land. The main reason for this is that on the earth's surface, for every square mile of land, there are two and a half square miles of water; and in contrast to the trackless paths of the forest, rivers, lakes and seas offered him a natural highway, the advantages of which must very soon have been obvious. Moreover the waters provided Man with fish, and served as a natural barrier of defence. Most of the great cities of the world have been built on the banks of a river, or on an arm of the sea. Cities like London, New York, Bombay, Calcutta, and Singapore owe their importance almost entirely to their favourable position as ports; and Man has never ceased in his struggle to establish his mastery over the sea.

The first "boat" was probably a log of wood that floated past a tired swimmer; and once Man had learnt that things would float, development was bound to follow. Gradually the solid log took the form of a hollowed *canoe*, or a framework of wood covered with skins. Even to-day many of the rivers of India can only be crossed on a raft of skins blown up with air.

But the canoe was a clumsy vessel, requiring to be steered by a *paddle*, and driven by every current. The next stage was to add planks of wood to the hollow log, which became the *keel* of the boat, and a wooden rudder was fixed at one end, which could control the direction in which it moved. Probably man borrowed this idea from watching the movements of fish. A little later he found that a skin, stretched tight and fastened to a post fixed to the bottom of the boat, would take advantage of the power of the wind. Hence arose the 'mast' and 'sail' which have been used in ships until the present day. But once this stage was reached there was no new discovery of principle until the closing years of the nineteenth century. Progress was shown by increase in size and in the number of *oars* or paddles used, by improving the shape of the rudder and keel, and by enlarging the area of sail.

We still do not know the full story of *Viking* voyages. But from the discovery of buried ships in the shores of North America it is quite clear that the *Norsemen* crossed the wild Atlantic waves, in fragile little vessels which we should now consider unsafe even for a short journey on a river. Their ships were propelled both by oars and sails, and it is almost impossible to imagine the courage which such voyages must have required—alone for nights and days on end, at the mercy of the Atlantic waves, which are still a source of fear to men. But the Norsemen are famous for their bravery, and they were the earliest European race to overcome the terrors of the sea. Their deeds are celebrated in prose and verse, and the English love of the sea is largely due to the mixture of Norse blood which runs in English veins.

The Roman merchant vessels had no oars. They were driven by sails only, and the rudder was fixed on the side, very much in the same way as a paddle is used by the boatmen in Kashmir. The modern sailing boat is a development in detail and principle of these Roman vessels. Nothing new was achieved till about 1830 when steam was used to replace the wind as a driving force. But so much had been done already by the sailing boat and the bravery of seamen of all countries, that the introduction of steam has added only speed and comfort to travelling on the ocean highways of the world.

In the days before recorded history Hindus and Arabians in the East, and *Phoenicians* in the West, held command of the sea. There is reason to believe that parts of the coast of America were known to Hindu sailors. It is certain that Phoenician sailors went round Africa long before *Diaz* or *Vasco-da-Gama* ever thought of a sea-route to India Because of their great skill in trade and *navigation* the Phoenicians sailed far and wide across the seas. They founded colonies on the African coasts, of which *Carthage* became the wealthiest and the most powerful. They founded another colony at Cadiz in Spain, passed through the straits of Gibraltar, and found their way north to the tin mines of Britain. What has now become a proverb in the British Empire, was partly true of the Phoenicians too : "Trade follows the Flag." Where-ever the Phoenicians went they established their colonies and trading centres.

With the fall of Carthage the Phoenician power declined. With their decline seems to have been lost much of the knowledge of ship building and navigation known to them. But there were already two clearly-defined classes of ships ; the vessels of war, propelled by sails and oars, and the merchant ships which depended upon sails alone. For centuries afterwards all progress was along these lines and no great sea-power arose until the days of the great Italian city-republics, of which *Venice and Genoa* are the most famous. Their trade was confined mainly to the Mediterranean—though fleets of Venetian ships brought cargoes of silks and spices from the East to English shores, which had been carried overland to Constantinople. It was the closing of this land route to India and the East, when Constantinople was captured by the Turks in 1453, which provided the immediate cause of the next burst of activity in the history of shipping and the rivalry of English, Spanish, Portuguese and Dutch sailors gave a political importance to the struggle for mastery in trade.

The trade to India with its gold and jewels, its silks and rate spices, was a source of wealth which the great nations of Europe tried to capture. Italian sailors, without support or financial help from their own country, put their knowledge at the service of the kings of Spain and Portugal, the leaders then of the European states. In Portuguese and Spanish vessels, they sailed southward along the African coast. It is worth noticing that each of these expeditions ventured only a little further from lands already known. They penetrated into the unknown by inches. There was a general belief among all sailors that a route to India could be found by sailing West. But no one had the courage to launch their boats into the Great Unknown. It remained for the splendid courage and faith of Columbus to sail across the Atlantic to the West, with only three vessels, the biggest of which was no larger than a modern river boat. For a long time he believed that when he touched the coast of North America he had reached India and the East. He announced that he had discovered the lands of the Grand Cham of China; and the name of West Indies still remains.

With the discovery of America, navigation progressed very rapidly. Within thirty years

Vasco-da-Gama had discovered the sea route to India round the Cape of Good Hope : *Magellan* had sailed round the world with a mutinous crew of sailors. In the reign of Queen Elizabeth *Drake* and *Frobisher*, *Davis* and *Hawkins*, *Raleigh* and *Gilbert*, proved themselves as daring as the sailors of Spain or Portugal. But the great rivalry of all the sea-going nations for the trade of the New World and of the East, led to piracy and war ; and voyages of exploration and trade developed the need for "men-of-war." Henceforth the two types progress side by side, until we reach the great battle-ships and liners of to-day. But the greatest contribution of the sixteenth century was a spirit of seamanship, and love of the sea which, greatly assisted by the invention of the "*mariner's compass*," still produces fine sailors in all countries dependent, like England, upon the sea.

Between the sixteenth and nineteenth centuries Europeans continued their voyages of discovery. All the lands in the Pacific and Atlantic oceans have been gradually discovered and colonized. The discovery of the Australian group of islands by the English sailor *Captain Cook* was quite as important, though not nearly so remarkable, as the discovery of America by Columbus.

In navigation, as in other branches of human knowledge, the nineteenth century is an age of wonder. The huge monsters of the sea that now steam from port to port carrying thousands of passengers, or tons of cargo, would seem impossible nightmares to men like Drake, who sailed round the world in a vessel of little more than 100 tons. Vessels like the *Queen Mary*, *Normandie* and *Europa* are dreams of luxury and comfort. Their size ranges from fifty to more than seventy thousand tons. They cover the distance between Europe and America in four or five days. They carry on board all the comforts and amusements known to man. They have become floating hotels, and even contain shops, cinemas, swimming pools, telephone exchanges and business offices.

The main point of a vessel designed for trade is its strength ; it must be able to survive the most violent storms and yet possess the maximum storage capacity for cargo. The modern fishing boat, and the Eastern *dhow*, are probably fair examples of what the earliest trading vessels were like. Between them and the modern cargo-boat or "*Tanker*," which is no more than a hollow steel shell, there is little difference except of size and power. With merchant vessels, speed is a secondary consideration ; strength and reliability and the capacity to transport the greatest quantity of goods over the greatest distance, are the main consideration.

Another branch of shipbuilding which must be mentioned, is that of warships. The Romans were famous for the size and speed of their ships of war, which were known as "galleys."

They were long, narrow boats with rows of oarsmen sitting one above the other along the sides of the boat. Sails were also used when the wind was favourable. But the galleys did not depend only on the winds. Some of the war-galleys were manned by two, three, or even four lines of rowers on each side of the boat. The highest oars were very long and heavy requiring several men to each oar. The rowers were generally slaves condemned to the galleys for life. They were under the supervision of an overseer who stood above them calling out the time, and using the whip very frequently on the backs of the poor galley slaves, whose lives were considered of no value at all.

In *medieval times* there was little development of the fighting ship. A naval battle was still regarded as a battle fought between soldiers on the sea ; and a sea-fight generally took the form of a hand to-hand struggle between ships lying alongside each other. In Elizabethan times, the English seamen, profiting by lessons learned during many voyages of piracy and exploration, added a line of guns on each side, called a "broadside," and introduced new naval methods of fighting. Their ships were small enough to shelter themselves below the Spanish guns, and at the same time were fast and light enough to escape. It was this policy which overcame the splendid but clumsy Spanish ships in the *Armada*.

From then until the nineteenth century, the main lines of progress were in carrying more and heavier guns and in increasing the size and strength of fighting ships. But they were still made of wood, and their motive power was still the wind. It was the discovery of steam and the invention of armour-plating which revolutionized naval warfare. In between the first armoured vessel, which made its appearance in the *American Civil War* in 1862, and the modern battle cruiser of over thirty thousand tons, carrying an armament of sixteen-inch guns, there lies an interval of less than a hundred years so rapidly has Man adapted the inventions of peace to the arts of war! To-day the navies of the world contain not only heavily-armoured vessels which are proof against the wildest storms, but fast torpedo-boats and destroyers and submarines which move underneath the surface. Many of the naval battles of the Great War (1914—1918) were fought at a distance of fifteen miles between the rival fleets, out of sight of each other, with hundreds of tons of shells being flung into the sea every minute.

Of all the modern warships perhaps the submarine deserves a special mention. The first under-water vessel was intended to lay an explosive charge beneath an enemy ship, and then retire. But the invention of motor and electric power rapidly developed this new ship, into one equally at home on the surface or beneath the waves. It can see, even when under water, by means of a long tube with mirrors called a periscope, the top of which just projects above the water. Its principal weapon of attack is the "torpedo"—in itself a small explosive submarine shell, though without a crew, and moving under its own power. Submarine warfare has added a new danger to civilization, and many million tons of food are now lying at the bottom of the sea, since the sinking of merchant ships by torpedo was begun in the Great War of 1914-18.

There are few more interesting places in our world than a modern Dockyard. In the harbours of Bombay or Calcutta, for instance, we may find ships from all four corners of the world, of every size, and for every purpose, from the sailing *dhow* to the mail steamer. Few of man's achievements have been so rapid and so varied in their development. It would be impossible to mention here more than a few of the different kinds of ships now being built in the dockyards of the world. There is a type for every purpose of peace and war. From the fastest motor-boat, capable of more than a hundred miles an hour, to the heaviest cargo boat, carrying the products of one continent to supply the needs of another ; coal ships from South Wales : fruit ships from Australia, South Africa, and the West Indies : cotton ships from India, Egypt and America : grain ships from Canada and Australia : cattle-ships from New Zealand and the Argentine ; oil tankers from

Burma, Persia and Iraq ; all these may be seen on the highways of the sea. From the mighty battle cruiser to the fast destroyer ; from the hidden submarine to the aeroplane-carrier ; from the monster of the deep carrying sixteen inch guns, to the innocent '*tramp*,'—there are more varieties than can be mentioned. There are no limits placed upon Man's inventive genius except the wealth of a country ; for the building of an ocean liner, or of a battle-ship, may cost as much as five or six million pounds. And for every mile of extra speed which it is desired to achieve beyond a certain limit, the cost of a vessel nearly doubles itself.

In the last few years indeed, the transport of the sea has been revolutionized. Distance has neither fascination nor fear for man now. All parts of the earth are linked together ; there is nothing strange or unfamiliar. The produce of the East may be exchanged for the produce of the West ; the world has become one large bazar, and men of all nations may buy and sell in it, with equal ease and profit.

CHAPTER IV

THE CONQUEST OF DISTANCE IN THE AIR

In the ancient Indian stories, the Mahabharata and the Ramayana, we read of kings who used flying machines. It is said of Rama, the king of Ayodhya, that he flew to his capital after his victory over the king of Lanka. His queen and his friend, Hanuman, accompanied him in his aerial car. Even if the Hindus knew the secret of aerial flight, it was lost by the beginning of recorded history. The story shows, however, how men have always dreamed of rivalling the birds of the air; how swift and graceful movement through the air has appealed to their imagination. From the earliest times indeed, efforts have been made to rise into the air. It was not, however, till the year 1783 that a definite effort was made to travel through the air.

Two young Frenchmen, the sons of a paper merchant named Mintgolfier, constructed a balloon and put a sheep, a cock, and a duck in it. Rather like the *Ark of Noah*, this French balloon took this unusual cargo into the air before ever. Man ventured to fly into unknown regions above him. The balloon ascended gracefully to a height of about 1,500 feet, remained at that height for a while, and then gradually it fell through the air till it reached the earth. In the same year another attempt was made to fly. This time the experimenters themselves, two Frenchmen, named M. Rozier and Major Arlande, became the passengers. They ascended in a big balloon in the presence of a crowd anxiously watching the result of their daring experiment. The airmen seemed to regard their experiment very cheerfully, and earned the admiration of the by-standers by waving their hats to them. This balloon is supposed to have reached a height of 3,000 feet above the earth. They remained in the air for quite half an hour.

This year, 1783, seems to have been a time of remarkable activity in flying, for a third attempt, this time with a balloon filled with hydrogen, was made by another Frenchman named Charles. Working on these discoveries the English Channel was successfully crossed in a balloon. During the following years of the century, flying in balloons was seriously studied in France, and many trial flights made successfully by French scientists.

During the greatêr part of the nineteenth century, the minds of men were too occupied with industrial and economic problems to pay serious attention to the idea of flying. Moreover, the steam engine which revolutionized land and century, about the same time that the internal-combustion engine was invented, that scientists began to study the possibilities of flight. But the differences of opinion among them were so great that quite often it was declared that the achievement of flight by man was an impossibility.

An American, Professor Langley, however, held a different opinion. From 1887-1900 Professor Langley studied on theory, and by experiment, the conditions of flight in the air. He proved that an object moving through the air could balance itself, if it was moved fast enough. He constructed models to show that his conclusions were right. But in spite of these demonstrations few believed in the theories advanced by him, or in the possibilities of aerial flight, except two unknown mechaincs, the owners of a small bicycle repair-shop in Dayton, a town in Ohio, a state of the U. S. A. The two brothers, Orville and Wilbur Wright were not "men of science," nor had they ever been to a college or a University. But they were men trained to do things with their own hands, to observe carefully, to make up their minds slowly, and to test their results. They did not understand the mathematical principles underlying flight, but they had read with great interest accounts of the experiments in *gliding* by European and American scientists, Above all, they had studied the movements of winds and of birds. They had spend their youth flying kites when they had nothing better to do. They would lie tor hours on their backs and amuse themselves with watching hawks as they floated and circled overhead.

For several years the Wright brothers could arrive at no definite conclusion. The theories of the scientists did not agree with their own observation and experiments. In the beginning of 1900 they decided to build a glider according to their own design, and to try it under the most favourable conditions. They enquired from the United States Weather Bureau and learned that Kitty Hawk, in North Carolina, was just the spot where steady and strong winds blew. In October of that year they pitched their camp on top of the hill, and on the wind swept slopes of Kill Devil Hill they began their study ot the laws of the air.

For the next three years, their life was spent in patient toil between Kitty Hawk and Dayton. The autumn was spent in experiment on the top of the hill, with gliders which were built in their little workshop during the rest of the year. It is only a bad workman who complains of his tools: Orvile and Wilbur were content to set right all the faults they discovered in their machines, with the tools they had in their tiny repair shop.

Towards the end of 1903, these determined mechanics had built themselves a machine driven by a twelve horse-power petrol engine. intended to give a speed of thirty miles an hour.

The wings which balance a flying machine, like the wings of a bird, and the rudders which change its direction, like a bird's tail, were also of their own design and making. A seat for the pilot was built in between the wings, very much in the same way as the seats in a modern aeroplane.

At last on December 17, 1903, rising into the cold air of the North Carolina coast one of the brothers guided the *biplane* on its first flight. For the first time in history a self-propelled aeroplane made a flight and landed back in safety. They made four more successful flights the last of which continued for fifty-nine seconds, and covered a distance of eight hundred and fifty feet. The brothers were happy, but not noisy about their achievement. "The age of the flying machine has come at last." Once more the "impossible" had been achieved, though only two years before, a well-known astronomer had declared that the construction of fan aeroplane that would carry even a single man required the discovery of some new metal or some new force.

But we must admit that the rapid advance in air navigation during the last thirty years is less due to the success of the Wrights, than to the Great World War of 1914-18. The Wrights were modest people ; they did not seek popularity or fame and it was not for another four years that their work was generally known

Engineers of other countries had in the meanwhile arrived at very similar conclusions, and built similar machines in Europe. But the type designed by the Wrights was adopted in most countries, although *Bleriot* established a new record by crossing the English Channel in a monoplane in 1911. Beginning as humble mechanics the Wright brothers had laid the foundation for all future progress in aviation.

The aeroplane is a machine heavier than the air. It has power to rise above the earth, power to remain there, and power to come down at the will of the pilot who works the controls. From the small one-man machine, to the largest flying boat capable of carrying several tons of luggage and one hundred passengers, the principle is the same as in the flight of birds. A body heavier than air rises by its own power, and stays in the air so long as that power is maintained. For swiftness of movement, for long flights, for rising to great heights, for conquest of the air, this type of machine is unequalled. To fly at four hundred miles an hour, to swoop within a few yards of buildings and houses, to twist and turn round and round till watchers standing firmly on the ground began to feel dizzy, are some of its ordinary achievements.

But it is very sad to realize that progress in aviation has been largely due to war, and to rivalry and hatred among the nations. The

War has shown how terrible can be the effects of aerial bombardment and warfare. The aeroplane, which ought to have linked continent with continent, and drawn men of all nations, closer to one another, has been used to bomb women and children, destroy cities, and rain down death and terror from the skies.

In the end, however, the wisdom and common-sense of Man will prevail, and the aeroplane will be devoted to the arts of peace. Even now in spite of war conditions, many parts of the world are still linked by air. Services between Durban (South Africa) and Australia and New Zealand are still being maintained. The American Continent is covered with a network of air lines. The American 'Clippers,' which are huge flying-boats, regularly cross the Pacific and Atlantic Oceans. All letters between England and India are being carried by air. Russian airmen have established a new route from East to West across the Arctic regions. Ceaseless experiments are being carried on to improve the comfort and design of aeroplanes, and to increase their speed, safety, convenience and usefulness. Perhaps it is no longer a dream to imagine that one day giant aeroplanes will fly into the upper levels of the stratosphere, and by making use of the steady constant winds which blow there, will fly round the world in two days. And yet it was only in 1903,—just 46 years ago—that the first flight was made !

Flying has indeed become a new means of transport,—of troops and guns and munitions in time of war, and of passengers and mails and goods in time of peace. Light aeroplanes are being built, as safe and easy to handle as small cars. Business men, and those with important public duties to perform, use the aeroplane as an ordinary means of conveyance. There are already air-taxis, and air cargo-boats, some of which can take off with equal ease from land or sea. Liners crossing the Atlantic and Pacific Oceans save one day in the delivery of mails by launching an aeroplane from their decks when still several hundred miles from port. Many warships carry an aeroplane to act as a 'scout' for them, and huge aircraft-carriers, holding a hundred planes, have become floating aerodromes.

One day, we must believe, all these inventions will be devoted to the progress, and not to the destruction of mankind; and perhaps the air will become so crowded with planes that we shall require air policemen to direct the traffic! Already machines can fly as safely by night as by day, keeping in touch by wireless communication with their home base. The speed and range of air transport has increased so much that continents which were separated by oceans several thousand miles across, no longer feel themselves isolated. Large air-ports offer scenes of activity and industry which remind one of the great sea-ports of the world. Air services work to time-tables as reliably and accurately as trains.

There is indeed a glorious future before air travel. Men will learn to use the air, as they now use the land or sea. To travel several thousand miles will take no longer and will be more comfortable and less tiring, than a journey of even a short distance a hundred years ago. People living in distant places, difficult to reach by land or sea, will have all the benefits of Science brought to them by air. The aeroplane will become as natural and ordinary a part of modern civilization as the bicycle and motor-car. And then the faith and patience and perseverance of the Wright brothers will have been justified. Then all the courage and skill and suffering which have enabled Man to add his conquest of the air to that of the sea and land, will form part of the heritage of civilization which future generations will enjoy.

CHAPTER V

THE CONQUEST OF TIME AND TROUBLE

The history of Man is largely a study of his efforts to make himself more and more comfortable, by adapting himself to his surroundings, and his surroundings to himself. Much of his energy and interest have been devoted to saving himself time and trouble, thereby increasing the pleasure of his work, and his hours of rest. At a time when his life was mainly spent in fighting for the physical necessities of life, (food, shelter, and self-defence), there was little rest or leisure for him. His hours were spent in finding and collecting his food, eating it, and sleeping of its effects. Yet the pictures on the walls of caves in the earliest period of human history show that from the very first, man has tried to use his leisure to increase his happiness.

Beauty, pleasure, and amusement, are possible only to those who have spare time. Therefore it is not surprising to find even the most primitive people inventing "machines" to economize time and labour. When the first man balanced himself across a stream, along the trunk of a fallen tree, he "invented" the first bridge. When he used a piece of wood as a lever to roll a heavy log, he laid the foundations of the science of mechanics. When he used two smooth stones to grind his corn, or made a rope from grass or the fibre of plants, he was already learning to use the forces of nature for his own ends. The earliest boat, and the earliest cart, like the earliest house and the earliest tool, were simply the expression of Man's desire to save himself trouble, and increase the comforts of his life. The wounderful hydro-electric schemes in India which generate enough electricity to supply the needs of an area of hundreds of square miles, are only a development of the earliest water wheel and grind-stone.

In our own times human cleverness and skill have achieved wonderful results. There are machines, large and small, that seem to imitate the human brain. They never make a mistake. If one single thread of cotton breaks on a modern loom or spinning machine, it stops itself immediately, so sensitive is it to accuracy. So wide and so varied are the uses to which modern machinery has been applied, that it is necessary to divide this chapter into two halves. The first part will deal with the application of power on a large scale, and the other with inventions especially adapted to the everyday needs of Man's life and work.

PART I.

A good exmaple of the application of power, is the modern Linotype machine. The old method of printing was from individual letters of the alphabet. The *compositor* had the *manuscript* spread out before him ; the letters were contained in a box with a separate division for each letter, and he took out one letter after another to make up words in a line. Line after line was thus completed till the whole page was composed and ready for printing. After the printing was over, the lines were distributed. It required great time and labour to sort them, and to restore them to their original divisions. This method of printing is still used in hundreds of small presses all over India.

But the Linotype avoids all this waste of time and energy. This machine is the most wonderful thing in the printing industry. It almost "thinks" like the man whose thoughts it sets into type. Like the typewriter it has a *keyboard* before which the operator sits. As his fingers press the keys this machine sets letters into words, and words into line. When the pages have been completed, stereo-type plates are prepared and they are transferred to large rotary printing machines. At one end is placed an enormous roll of paper, perhaps two or three miles long, which is passed between the sterio-plate and the cylinder and comes out at the other end as a folded newspaper ! One of these machines will print and fold a hundred thousand copies of a large newspaper in a few hours ; and in the same way books are printed and bound by machinery. When the type is no longer required it is melted down to be used over again.

This is only one example of the many curious and wonderful machines in one industry, out of all the thousands now pursued by man. Every big industrial town is a wonder-land of machinery; and practically everything we wear or use has been made, or partly made, by a machine. The cotton loom will weave with absolute accuracy a complicated pattern once thought too difficult for human fingers. Motor-cars are made in less than fifteen minutes from the time when their first two pieces were assembled. Glass bottles can be made by machinery at the rate of a thousand an hour; sheets of plate glass 400 feet long can be made, cooled, and cut up into pieces by one enormous machine; practically every action of Man's brain and hand can be done more rapidly and more accurately by machinery. The delicate parts of a small watch can be made by machinery; and *cows are milked* without the need of the human touch! There are even machines which can measure accurately to the millionth part of an inch!

The trains that carry millions of human lives over the railway lines of the world employ many inventions for their safety. It must be clear that the greater the speed of a train, and the greater her load, the more difficult it is to stop her in an emergency. Before the modern system of breaking was introduced it used to be the practice for every train to carry its own 'breaksman.' He travelled in a special carriage, and by using a large wheel he was responsible for putting on the brakes in case of need. But the brakes applied to the wheels of a single carriage could not stop the wheels of a whole train. Accidents due to the running away of trains down slopes, or to collisions, were quite frequent.

There are to-day two different systems of brakes by which it is possible to stop a heavy goods train moving at a speed of thirty, or a fast passenger train moving at sixty to eighty miles an hour, in a very short distance. Both the systems make use of air—one through creating a vacuum, the other through compression. The chain or handle in every railway carriage, is really a lever which puts into action all the brakes of the train. As soon as the chain is pulled it releases a valve in a vacuum chamber fixed under the carriage; the air rushes in and the brakes drop down against the wheels. To lift the brakes once more, the driver of the train creates the vacuum again by steam. As the air of the chamber is gradually driven out, the brakes slowly lift.

The other system of brakes works in a similar way—but instead of the vacuum the brakes are worked by compressed air. The pulling of a lever applies the brakes not only of the engine, but of the whole train, because the brakes of every carriage are connected with the rest of the train by a canvas hose-pipe which hangs between the hooks that join one carriage with another. Only the fastest and most important goods train—such as those carrying milk and fruits and meat—are at present fitted with these brakes. The older method of slowing down the engine, and allowing the trucks to bump into one another until they stop, is still very common. But this helps to show us how very recent many of our modern inventions are.

When we realize the great gain in speed and in safety which have resulted from these inventions, it is impossible not to feel grateful to the inventor, George Westinghouse, who was almost a boy when he made this great improvement in the system of braking. He was very fond of play, and he disliked school. His father was an engineer and the owner of a wood and machine shop. He was not pleased when George spent his time playing with the machines and making little inventions, instead of helping his father.

Once Mr. Westinghouse led George to a pile of pipes and told him to cut them into pieces of a certain length. "I am going away for a week. This will give you some work to do during my absence." Young George, who had formed his own planes for amusing himself was very disappointed, but not disheartened. Within a few hours of his father's departure he had invented and put together a machine which took the pipes and cut them into the required lengths.

A few years later another very similar occasion gave us the famous Westinghouse brake. One day, when he was hardly twenty, he was travelling by a train which came suddenly to a standstill. Going forward to learn the cause of the delay, he discovered two damaged engines, and heard the story of a head-on collision. But the railway line was perfectly straight for miles ahead, and when he heard that the drivers had seen their danger but could not stop their trains in time, he determined to overcome this problem. He conceived the idea of a brake that would work throughout the train, and the designed the brake that has already been described.

Later he became a great inventor in railway electric works. He designed an "inter-locking" device by which the entrance of a train to every station is controlled by a system of points which sets the lines in one direction or another. The points are opened by keys. Westinghouse designed a simple key-box, so that once the point was set in a certain way it locked the points controlling the same line from the opposite direction. By this simple invention the risk of collision is very much reduced. He also devised various methods by which the movements of trains between one station and another can be watched and controlled from the station signal-boxes. A modern signal-box is one of the most interesting places in the world. All the signals and points are electrically controlled, so that once a train has been admitted to a platform, the line is locked until it is free again. The movement of every train can be watched on a coloured chart; and so rapid is this method of control that one man can arrange the arrival or departure of several trains every minute.

In the biggest cities of the world, like London, Paris, Berlin, Moscow and New York, much of the traffic travells underground. Far down below the surface there are tubes and tunnels, through which electric trains thunder at the rate of one every thirty seconds. These trains are reached by electric lifts and moving staircases; and by this means it is possible to travel from one end of a city to another, underneath its biggest buildings and streets and rivers, in much less time than it takes to travel by car through the crowded streets. The trains themselves are practically automatic and only require the action of a man to stop and start them; should his hand fall off the starting handle, the train at once comes to a standstill. The trains even operate their own signals. Each tunnel is divided into sections: so long as a train is in a section, the entrance to that section is guarded by a red light. But the moment it leaves the section the light flashes to green, and it is safe for the next train to follow.

More wonderful still, the Post Office in London has built an underground railway to carry letters and parcels between all the largest railway stations, which is operated entirely automatically, and without any human control whatever. At the Great Empire Exhibition held at Wembley in 1924 there was a non-stop railway, to carry passengers all over the grounds, which had no "driver" and which slowed down of its own accord when the various "stations" were reached. Nearly every large town in the world has its buses or trams which carry passengers about its streets at very small cost. They have no system of signalling or controls, but are part of the ordinary traffic; and in London it is sometimes possible to see a line of buses three or four hundred yards long, waiting to cross an important street. These are only a few of the ways in which man has applied the advantages of power to his needs of transport and communication on land!

Closely connected with this system of land transport, are the postal arrangements of the world. It is not so many years ago that letters were carried on the backs of men or mules; and still to-day in some parts of India dak runners take the place of the mail trains. Less than a century ago, *Rowland Hill* introduced the idea of penny postage, based upon the principle that a letter should be carried for the same sum, whether it is to travel a hundred yards or a thousand miles. It is thus possible to send a letter from one part of a town to another, or from London to Edinburgh, for the same sum. How great a part of modern life our postal arrangements form, can be imagined by supposing that they should suddenly cease. Business would come to a standstill, shops would soon be empty, friends and relations would lose touch altogether, men living in cities a hundred miles apart would become "foreigners" to one another.

Another branch of modern life which is managed by the Post Office, is that of the telephone and telegraph. In this respect India is ahead even of England; it is for instance cheaper to telephone from Amritsar to Delhi (about 300 miles), than it is to speak to a friend in England living only fifty miles away. The principle of both telephony and telegraphy is the same—namely the sending of a message either by the voice or by a signal code, along a wire stretched between two points. If the wire is broken during a storm, all communication ceases. These miles of telegraph wires may be seen running alongside most of the main railway lines and roads of the world. Both systems require the human touch; two people can only speak to each other by telephone when they have been connected by the operator. No telegram can be forwarded without the help of the human brain which sends it. But already the automatic telephone has been invented, by which it is possible to speak to a friend by moving a simple dial; and telegrams are now automatically received and printed without human aid, by a kind of typewriter which types of itself! Like the ordinary post, telephony and telegraphy have become a part of modern life—and countless thousands of messages are daily carried across the earth.

For telephony and telegraphy are not confined to the land. When *Morse*, an American painter, became interested in telegraphy, and after a struggle obtained a grant of thirty thousand dollars from the Senate, he did not know that one day telegraph wires would encircle the whole earth. Like many other inventors Morse passed his days in extreme poverty before he could convince the world that he had invented one of the easiest means of communication from one end of the earth to the other. The telegraph wires that carry the weak current of electricity over the land, are not the means by which messages are carried across the sea. The distances across the water from country to country are great. It is difficult to protect the wires from damage under the water, and there are no supports to keep them in position.

Because of these difficulties submarine telegraphy came into existence long after the use of telegrams on land. The one man who, more than any other, made submarine telegraphy possible, was *Lord Kelvin*. He went to Cambridge University at the age of seventeen and distinguished himself there as a mathematician. He was also a great athlete, and loved literature and art. At the age of twenty-three he was

Glasgow University, where he started his experiments in electricity. From the very beginning he devoted himself to the practical application of his discoveries. All his life he worked out problems of the most difficult character, regarding the strength, behaviour and effects of electric currents under all sorts of conditions.

The first long distance cable was laid across the Atlantic Ocean between Ireland and Greenland. There had been previous attempts, more or less successful, at telegraphic communication between England and France. But they had not been successful enough to prove that communication under the sea was really possible. Many attempts had been made in England and in America to connect the two countries. Hundreds of tons of cable were sunk in the ocean from 1857 to 1865, but for one reason or another, the cable broke in mid-ocean. At last in 1865 a cable was successfully laid, and worked well for two months, after which the messages became too feeble to be heard. The fact was that the strength of the electric current carrying the message was reduced in travelling along the cable owing to the thickness of the wire, the distance, and the action of sea water on the material protecting and covering the wire. Lord Kelvin studied these problems and made not only a better cable but also a very delicate receiving instrument, which would work even with very weak electric currents.

As a result of his efforts the world is now encircled by wires. Three lakhs of miles of cable have been laid under water. Millions of words per day are sent from one end of the earth to the other. The cost of sending these messages runs into thousands of pounds, as a cable is very expensive to lay. The electric current carrying a message passes through a very thin wire.

But this thin wire would break like cotton thread if it were not protected by layer after layers of rubber, coal-tar, hemp, lead or brass, and even steel. A cable is thickest near the shore, and grows gradually thinner in mid-ocean. It rests at the bottom of the sea, and the engineers experience great difficulty in raising it for occasional inspection. For, in addition to its own weight, the cable gathers weight from the sea plants and sea animals that grow upon it at the bottom of the sea. Sometimes a cable is pulled to the surface with a large piece of *coral* growing all round it, or some big fish is drawn up with it. Many years ago something went wrong with a cable near Valparaiso, in South America. When it was pulled to the surface, a dead whale was found with the cable coiled round its body. These are only some of the difficulties that the early pioneers of deep-sea cables had to face, and learn to overcome.

But Man is ever busy not only to overcome difficulties, but if possible to avoid them. The invention of wireless with its development in recent years, avoids most of the difficulty and expense of laying cables under the sea. Discoveries have proved that wires are not necessary, and that the electric waves will travel equally well through space without any wires at all. The first man to experiment with these wireless waves was the German scientist Hertz. He discovered that although waves of light will not pass through any thick obstacles such as a wall, wireless sound waves can pass through all matter without any difficulty. In other words, these waves are continually passing through the air, through trees, buildings and our own bodies even—though we need a special machine to hear them. The waves are not carried by the air, but they pass through it. They are very much like the waves of light, and move at exactly the same speed of 186,000 miles per second. That means to say that a wireless wave can travel right round the world, in much less than half a second! But the length of these waves can be altered; and so, each wireless station can use a wave-length of its own, which is different from that of any other station.

The first man to make practical use of Hertz' discovery was the young Italian inventor Marconi who died in July 1937. He found that the higher the mast from which he sent his waves the further they would travel, and by 1897 he was able to send a message four miles, using the Morse code. In 1899 he sent the first wireless message across the English Channel. That was followed in 1901 by the sending of a signal from Cornwall in England to Newfoundland in Canada. Wireless had proved its possibilities! But there were yet many difficulties to be overcome, and much is owed to the work of men like Sir Oliver Lodge who improved special receiving sets, for picking up these wireless waves and transferring them to paper or the human ear. It is possible to "tune" a receiving set so that it will receive any wave-length which is required, but neglect all the others. So it is possible to listen to London or Paris or Delhi or Calcutta or Berlin or New York one after the other, merely by turning a handle on the receiving set!

Other discoveries have proved that it is possible to send even pictures and the human voice by wireless. When the King of Great Britain makes a speech in London his voice can be heard in Bombay or Capetown or Sydney and important events are known in India only half a second after they have happened anywhere in the world. A man, speaking from an aeroplane flying above Buenos Aires in South America, was clearly heard by the Captain of a big liner which was only four hundred miles away from Southampton. Businessmen crossing the Atlantic can talk to their partners or friends on shore; photographs can be sent from one continent to another as fast as thought can travel. Ships and aeroplanes and motor-cars can be guided and controlled entirely by wireless waves without any human aid. During thick fog or heavy storms, ships and aeroplanes can be safely guided home. A ship has even been launched into the sea in Australia by pressing a button in England! Every passenger ship and aeroplane is now required by law to carry a wireless set. Sitting in our own rooms it is possible to hear the music of a concert played perhaps five thousand miles away. Travelling in a train at sixty miles an hour we can listen to a lecture or the latest news.

No invention of the last twenty years has made so much difference to the world. Bigger and more powerful stations are being built every day; and the latest discovery that wireless waves can be "*focussed*" or directed, like light, prevents them from being wasted all over the world; instead they can be sent in the direction required. To try and imagine the future is almost impossible. Ships guided without a pilot, houses lighted without any wires, food cooked and rooms heated by wireless waves, watching cinema films in our own homes, seeing people who are thousands of miles away—these are only a few of the possibilities. Wireless has put a 'girdle round the earth'; no invention has done so much to make men all over the world realize their common interests and brotherhood.

CHAPTER VI

THE CONQUEST OF TIME AND TROUBLE
PART II

It is almost impossible for us to imagine the world without trains and ships end aeroplanes. Those who live in towns can no more realize what our life would be like without telephones, and wireless, and electicity, than we can picture the misery of the world if the sun failed to rise one morning, or suddenly set in the middle of the day! We have become so used to all the wonders of mechanical invention that we hardly notice them. While we are sitting comfortably in a train travelling at sixty miles an hour, or crossing some famous bridge, we give practically no thought to the slow process of experiment and invention which has made it possible for us to do so. Fifty years ago a man would have been regarded as a lunatic who suggested that motor-cars would one day travel at over 200 miles an hour; to-day this has become so ordinary to us that it ceases to excite wonder. Men are now prophesying speeds of 400 miles an hour on land—that is four times the speed of the fastest express train!—and yet we do not regard them as foolish prophets: We only wonder how soon it will happen. Our grandparents were considered to be adventurous when they rode on a bicycle; our grand-children will probably all fly aeroplanes while they are still at school!

This means that we have grown accustomed to a world in which much of our daily work and pleasure is performed for us by machines. In the last chapter we were thinking of some of the most important features of modern progress, which are gradually lessening distance and abolishing time. But the smaller inventions and devices of every-day life are just as important. We cannot travel by train unless we have some means of reckoning the time; we cannot walk or drive to the station without inheriting the genius of those who invented the first pair of shoes or the first carriage; we cannot eat or dress without being dependent upon other men's labours. There would be no bread unless men grew wheat; there would be no wheat unless men had learnt to till and water the soil.

The publication of this book would have been impossible but for the fountain pen which wrote it, the machine which typed it, the machine which printed it, and the machine which bound it! Even our pleasures depend upon the skill and labour of others. To a visitor from another planet this would be a world of wonder and astonishment; to us it is something quite ordinary and matter-of-fact. In this chapter, therefore, let us attempt to recapture the sense of romance and wonder in everyday life.

It is a very long time since the first man boiled the first pot of water or cooked the first dish. He would find it impossible to believe the ease and simplicity with which we now perform these ordinary tasks. He was an inventor ; we are the heirs of all those who have perfected his invention. *James Watt* first learnt the power of steam by watching the lid of a kettle as it rattled and bounced from the force of the steam inside—and used this knowldge to build a steam-engine. But the boiling of a kettle does not even arouse our interest to-day ; we no longer need a fire but merely turn a switch and leave electricity to do the rest. The current passes through a long series of wires which offer great resistance, and become very hot ; the water is boiled, and all this happens without the smallest effort or exertion on our part. In the same way clothes can be ironed, bread toasted, and food cooked by this unseen force. Between the hottest furnace, used for making artifical diamonds from black carbon, and the smallest oven used for cooking our food, there is little difference except in size. A waterfall and an electric turbine, perhaps more than a hundred miles away, have created a force which we can use just when we want it, which will keep our food hot or cold, press our clothes, and light our houses and streets.

This means that no part of modern life has benefited so much from electrical inventions as the home. Only thirty or forty years ago houses could only be lighted with oil lamps, which required constant care and attention. Washing had to be done by hand ; furniture and carpets had to be carefully brushed and dusted everyday. But nowadays with electrical energy always waiting to be used, the modern housewife can have her home lighted with shaded electric bulbs, which require practically no attention all the year through. Instead of washing the clothes every week, she can place them in an electric washer which does all the work for her. She can press them with an elctric *mangle* and iron. (How the dhobies of India would welcome this application of power !) The furniture she can dust with a vacuum cleaner. (This last invention is based upon the fact that an electric fan, when revolving rapidly, creates a current of air. This current is drawn up into a large bag—and gathers up the dust and dirt with it.) Again we can keep ourselves cool in the hottest weather by electric fans. How many places in India have become much less uncomfortable in the fierce heat since the invention of the fan ! The comfort of every cinema and public hall depends upon their services ; railway carriages in hot countries and ships travelling through tropical seas, are fitted with them. Soon it is hoped that even the villages of India may enjoy the advantages of electricity.

One more remarkable use of the power of electricity which has already been mentioned, is its employment for cooking. Hotels and other houses which have to cook for a large number of people are rapidly employing electric cooking-ranges. They are perfectly clean, with no coal-dust or ashes to be cleared away each day ; they produce no smoke ; they can be made of white tiles which can be washed, and their temperature can be regulated as required.

But the benefits of modern invention are not confined to Man's work. Just because he has learnt to use machines to lighten his work, he has longer leisure for rest and enjoyment ; and here, too, the wonders of scientific discovery are at his service. All the great books of the world are available in cheap editions ; newspapers and magazines keep him in touch with all that is happening in every corner of the globe. He can lose himself in the African jungle and watch lions climbing trees. He can feel the icy blast of the mountain wind as he climbs the Himalayas ; he can imagine himself watching a Test match in England or India or Australia ; he can walk the streets of all the capitals of the world ; he knows by sight all the great men of every country. All these are made possible to him, by the wonders of modern photography. On the walls of his home he can hang coloured reproductions of the world's most famous pictures, which are almost impossible to distinguish from the originals. On his book-shelves all the world's wisdom can be stored for his learning and pleasure. In imagination he can travel with the great explorers, fight the greatest battles, admire the finest buildings, become a statesman, an artist, an inventor—without ever leaving his own arm-chair. At his elbow, by the invention of the gramophone, lies ready all the finest music of the world, played and sung by the finest artists.

It was *Edison*, (who probably made more important inventions than any other man), who constructed the first gramophone. Sound travels in waves, and he used this fact to transfer sounds to a wax disc. When a voice sings into a specially constructed horn, the waves are carried through a sharp steel needle, which rests on a revolving wax disc. As the needle goes up and down it cuts a channel in the wax which is sometimes deep and sometimes shallow. An exact copy of the wax disc is then made in vulcanite. If this new "record" is then placed on a gramophone, the needle will move up and down as it did before, and repeat the original sound waves. These are transferred through a very delicate piece of mica called a diaphragm, and magnified by a metal or wooden horn.

When a sound is 'echoed' by a wall or a hill, it is illustrating the principle of the gramophone horn. But out in the open, across a great distance, the sound which travels very slowly takes a long time to return. When a gun is fired from some distance away, we can see the flash and smoke long before we hear the sound. In the same way the thunder really takes place before the flash of lightning ; but light travels so much faster than sound that we see the flash first. Inside the gramophone the sound can be "reflected" so quickly that it echoes as rapidly as the original sound is made ; and in this way a small gramophone can fill a large room with the noise of an orchestra or singer. Perhaps no other simple invention, apart from the cinematograph, has done so much to bring happiness and pleasure into millions of homes. Without any effort on our part at all we can listen to all, the finest singers, the most brilliant players, and the most famous orchestras in the world. The great singers and speakers of to-day can be recorded ; and not only their words but their actual voices will be heard a hundred years hence.

This same principle is used in business, by means of an instrument called the 'dictaphone'. A wax-record is put in position and the machine is started. The man who is using the machine, talks into a tube, and the sound-waves of his speech are recorded on the moving wax-cylinder. One "record" will hold perhaps five or six letters. Then comes the typist. When he is ready to type the letters, he sits near the machine, puts two receivers to his ears and moves a lever. The wax-cylinder begins to unroll the speech, and the speed can be controlled as he likes. When the cylinder has been filled, and the letters typed, a thin film of wax is shaved off, and it can then be used again. In this way a man can record his thoughts as soon as they occur to him.

without being dependent upon a *stenographer* to take them down ; and many authors write their books in this way.

There are also many other ways in which modern invention has come to the aid of business. Type-writers have been improved until they are practically soundless ; they can be used not only for ordinary Roman letters, but for music and oriental languages. Experts can write with them twice as fast as the human hand can use a pen—and with far greater neatness and accuracy. Very similar to the type-writer are adding machines and cash registers. These machines will perform all the work of the human mind. There are some men who can add up four columns of figures all at once ; but the machine will add six columns with perfect accuracy. When the keys are pressed as on a type-writer, it will transfer the figures to a sheet of paper, and print the total at the bottom without even a second's pause ! In big banks and business firms these machines are being used more and more and they have greatly reduced the labour and difficulty of keeping accounts. Like the type-writer, how useful they would be in a Mathematics examination !

Cash registers too have become an essential part of modern business equipment. When a purchase is made, a key is pressed ; the amount of the purchase appears in a window which the customer can watch, while the correct change and a printed receipt are released without the need of any human calculation. In the underground railways of London, by putting a coin into a slot, a printed ticket and the correct change are produced, and the great leading to the trains is automatically opened. Thus no one can board a train unless he has paid for his ticket. Matches, chocolates and other things wrapped in small packets, can be obtained from automatic machines merely by putting the correct amount of money in the slot. In this way things can be bought long after the shops have closed, and the owner can collect his money in the morning. If the scientists are right, who prophesy that one day we shall be able to concentrate all the nourishment necessary for a day's work into a small tablet, then we shall one day be able to buy a week's food by putting one rupee in a slot!

But of all the inventions which man has made to increase his pleasure the cinematograph is by far the most important. Millions of men and women, tired after the day's work, obtain rest and interest and refreshment from films. Education has been greatly enriched by them. It is now possible to watch the processes of nature in slow motion, such as the opening of a flower, or a butterfly coming out of its cocoon. The growth of the cinema has been a process of gradual development rather than of sudden invention. It depends upon the science of photography without which it would have been impossible.

The first stage of development was reached with Horner's "Zoetrope" or "wheel of life," in 1833, by which a number of drawings were quickly rotated, so that the figures in them seemed to be actually moving. This was followed by a clever thought of an Englishman called Muybridge, who fixed up twenty-four different cameras, and stretched a string from each across a race-course. As the horse galloped down the course, it broke each string in turn and so took twenty-four photographs of itself. But this method would require far too many cameras for ordinary use, and much is owed to the work of George Eastman, of "*Kodak*" fame, who invented a film suitable for moving pictures.

This was followed by the first moving picture camera in 1889, and the Edison 'Kinetoscope.' In the latter a series of photographs was rotated by hand and the figures in them appeared to be actually moving. This was the first simple "projector" and the parent of the modern machine now used in cinemas all over the world. The first successful attempt to throw moving pictures on a screen was made in London in 1895 by a man named Paul, and from that moment, moving pictures have developed into one of the most important industries in the world. The principle of the projector is a simple one. Moving figures are photographed on a series of small 'negatives' each one showing a slightly different position from the one before. They are then printed on to a 'positive' film and this is passed through a machine with a very powerful light. The photographs move so rapidly that they appear to be continuous, and so the movements appear on the screen exactly as they were originally made. This means that perhaps thirty or forty photographs have been taken in order to show one complete movement and so important films are sometimes between two and three miles long. By taking the original photographs very fast, each exposure will show only a tiny part of each movement. And this produces what are called "slow-motion" pictures, in which it is possible to see every tiny detail of a man or horse taking a jump, or a man playing tennis or cricket. These will undoubtedly be used more and more for educational purposes.

A still more recent invention is the "talking" or "sound" film by which the voices of the actors can be heard at the same time as their movements are seen on the screen. So rapidly have they developed in the last five years that "talking" pictures can now be found in almost every town in India, and even in some large villages. No invention in the whole history of Man has done so much to give all the peoples and countries of the world common interests, common ideals, and common pleasures. The cinema is also being used to an increasing extent in education: and in western countries every large school has arrangements for showing films which illustrate and explain lessons in History, Geography and Science.

Closely allied to wireless and the cinema is "*television.*" This is an invention by means of which sounds and pictures can be sent through the air together, without any wires. One of the earliest developments of wireless was broadcasting,—or sending programmes of music and plays and news and talks into the air, which could be received by any one owing a wireless 'set' in his own home. This has become one of the most important influences in modern life and is rapidly developing in India. And now television programmes have been introduced in England and America and Germany, where owners of special receiving sets can both see and hear programmes which are being transmitted through the air. It is certain that future generations will have new wonders to amuse and astonish them. The inventions and discoveries which excite our wonder and puzzle our understanding will be to them quite ordinary. For the conquest of time and trouble is unending and each new invention brings with it the need for still further improvement.

CHAPTER VII

THE CONQUEST OF RESOURCES

As we have already seen, the history of Man's progress is very largely a process of adapting himself to his surroundings. He has always made the most of the natural advantages which the earth offers him just as men once learnt that a hollowed tree would make a very serviceable boat, so to-day men are wondering whether the energies of the sea tides can be harnessed to their service. Discoveries that seemed marvellous a hundred years ago are now commonplace; and those inventions which astonish us will one day become ordinary and matter-of-fact. But the story of how Man has slowly learnt to understand and use all the forces which the earth offers him is bound to contain the main facts of his progress.

The resources of the world are those natural advantages which can be adapted by Man's skill to perform services, or provide advantages, which he would not otherwise possess. Probably the earliest to be employed was wood. Branches of trees served as a covering from the heat or from the rain; rough handles for weapons and tools could be shaped from them; carts and boats could be made from their trunks. Moreover wood was an essential part of man's greatest ally—Fire!

As cutting tools improved, wood could be adapted to more and more purposes ; and it is interesting to realize how many things which we use every day are still made of wood. The windows and doors and ceilings of our houses ; much of our furniture ; many parts of our ships, and trains and motor cars—these are all dependent on the forests of the world. Man has discovered that from crushed wood, which is called 'pulp,' paper can be made. Tens of thousands of trees are cut down every year, to be turned into newspapers and books ; great masses of logs may be seen floating down many of the rivers of the world, on their way to the saw-mills below. But Man is very wasteful with those resources which cost him nothing ; and unless he is careful to plant a new tree for every one which is cut down, the forests of the world will one day become exhausted.

Far back in the earliest days, however, men felt the need of something harder and stronger than wood. The thick wooden club was a good enough weapon while it lasted, but it was inclined to break. Roughly sharpened stone or flint heads fastened to the end of a wooden handle, were found to be more useful ; and a whole stage of Man's progress is called "The Stone Age" because of this discovery. Stone was useful too for building houses and making tools : the only thing needed was to *quarry* it from the ground and roughly turn it into the shape and size required. There is evidence that ten thousand years ago men knew the use and advantages of stone; and the ancient *Egyptian Pyramids* are proof that knowledge of the use of stone is very old.

The "Stone Age" was quickly followed by the "Bronze Age," and knowledge of the use of metals. Tin and copper which were found near the surface of the earth were soft enough, when heated to be hammered and shaped, but hard enough to be used for cooking vessels and spears and tools. Perhaps some night-watchman banked up the camp fire with lumps of *Copper ore* lying near by and noticed with surprise the bright colour of the metal as it reflected the firelight. By itself it was far too soft to be of very great use; but when mixed with tin, the new metal, bronze, was found to be much harder and stronger. Bronze axes enabled man to cut down trees; bronze chisels helped him to quarry stone; and tribes armed with bronze weapons quickly overcome their enemies. To-day bronze is not very much used; but copper and tin are still of tremendous importance. Nearly all electric wires are made of copper; and tin has been so much used, and the number of tin mines is so small, that tin is now one of the rarest and most expensive of the common metals.

The discovery of copper and tin was soon followed by that of iron. The tribes living in the neighbourhood of iron-mines quickly became leaders and conquerors. Iron weapons and tools were sharper and stronger than those of bronze. Five thousand years ago the discovery of iron made as much difference to the world, as the discovery of *steel,* in the nineteenth century, has made to us. Ever since its first discovery, iron has been the most important metal in the service of Man. To-day practically every machine and invention depends upon the use of steel in one of its many forms, until it has been found possible to produce steel, able to stand strains of over one hundred tons per square inch. How primitive man, who chipped his rough iron axe on a hard lump of rock, would have envied us the strength and cutting power of steel !

Until the eighteenth century when English coal was first used to *smelt* English iron, and convert it into machines, Man was still compelled to do all his work by hand. It was the discovery of the power of steam and of the strength of iron which made possible the development of factories and the modern age of machines. Coal and iron in fact are very closely related. Coal is used to smelt the iron, and to make the steel ; the steel is made into machines ; and coal is used again to generate the steam to work the machines. In consequence the world's supply of coal is running short and scientists are faced with the necessity of finding new sources of power. Moreover to burn coal is a terrible waste of many other valuable things. For coal yields chemical substances which are of the greatest importance. From it can be obtained coal-gas, tar, dyes, sugar, petrol, drugs and explosives; and every time that coal is burnt in a fire these substances disappear up the chimney in smoke. Within a few years electricity or oil will probably be used everywhere instead of coal to warm our rooms, generate our steam, and cook our food. Then the coal which is still left in the earth can be compelled to yield up all the chemical treasures which are stored in its heart.

But until this happens the coal-mining industry will continue to be one of the largest and most important in the world. Many mines, from which the coal could once be dug quite near the surface, are now many thousands of feet deep. The men working in them are faced with all the dangers of floods, sudden falls of rock, and explosions of gas. They work by the light of safety lamps, and cut the coal from the coal-face by means of picks or electric drills. The coal is then carried by underground railways to the pit-shaft whence it is carried to the surface by lifts. Each pit has two shafts. They are used for the miners themselves and for the coal, and also serve as *ventilators*, a cool current of air being sucked down one side, and a hot current of used air being driven up the other. Coal mining will always be one of the most dangerous industries in the world; and many miners are now out of work and starving, because it is no longer possible to raise coal from their mines at a price which people can afford to pay. The only solution is to use the coal, not for our fires and furnaces, but to extract from it the many chemical substances which it can yield, and to increase its value once again. How strange it is that decayed trees, ferns and plants—once growing in the green forests of the earth and compressed during the centuries into hard black coal,—should yield so many treasures !

Near many coal-fields will be found blast furnaces and smelting works, where iron ore is converted into different kinds of iron. The iron ore is placed in huge furnaces. and heated to a tremendous temperature, until it becomes liquid or molten. To it are added various substances to harden and strengthen it, and then it is run out in streams of liquid fire, and allowed to cool in sand channels. These blast furnaces never go out from the beginning of the year to the end. and their glow may be seen in the sky from a great distance. When the iron has cooled down, it is picked up by enormous *cranes* and sent off to the steel works, where it is again melted and tempered and converted into the strongest steel. But this process involves a tremendous waste of good coal ; and men like Henry Ford invented ways of burning all the rubbish and waste of the factory in these furnaces, with equally good results. It is in ways like this that man is learning to value and preserve his resources.

Another of nature's resources which has been universally adapted is the air. In the very earliest days a current of air was used as ventilation, and it was not long before it was filling the sails of ships and driving rough *wind-mills* to grind corn. In countries like Holland, much work is still done by these wind-mills which give considerable power at practically no cost. In our own times the air has been put to still further uses. It is now very little used for propelling large vessels, though small pleasure *yachts* are still driven by sails. But airships and balloons, and to some extent aeroplanes too, are dependent on the strength and direction of air currents. Moreover the air is a mixture of two important gases, nitrogen and oxygen, and chemists have discovered that from the nitrogen in the air it is possible to extract many important chemicals. For instance, chemical compounds called nitrates are very much used in agriculture, since they make the soil bring forth a richer harvest ; but their supply in the earth is almost exhausted, and now men have discovered that they can be obtained from the air instead. This is another example of the wonderful way in which Nature comes to the rescue of Man's need, and yields up fresh knowledge of her treasures.

Closely connected with the air is water, and water-power was one of Man's earliest resources. He was at home on the rivers of the forest, long before he had learnt to build roads. From their depths he learnt to catch fish, and by their means he learnt to turn small water-wheels which would grind his corn or spin his cotton. Nor has this usefulness of water ever decreased. Across the oceans of the world, liners and cargo-boats are passing every hour. Enormous quantities of electric power are generated by water *turbines* at a low cost. Men are now beginning to wonder whether the restless energy of the waves and tides of the sea, cannot be harnessed to their ends. From its depths they draw a rich harvest of fish,—which still forms the main food of many peoples who live on the sea-shore. Man has even brought water into his own home,—using it for drinking and cleaning; and in India, where water is scarce, men and women may be seen walking backwards and forwards to the nearest well or tank, in search of the one resource without which they cannot live.

Another source of power, which Man has only recently learnt to use, is oil. The invention of the internal-combustion engine made necessary the discovery of a liquid which would quickly become a gas, and so could be exploded. This was found in petroleum, which is drawn, like water, from wells, except that the petroleum rushes upwards of its own accord with the pressure of its gases, and has only to be collected in tanks and barrels. Every motor-car and aeroplane depends upon the world's supply of petrol, and to-day men are slowly learning that even in its impure state it can be used instead of coal for heating furnaces and boilers. It is far more economical, much easier to store, much less dirty and far cheaper to use. In the great ports of the world it is most interesting to watch some old fashioned ship taking in coal, with hundreds of coolies swarming about her black sides, while near-by a modern ship pumps in her oil-supply through a hose, and no one but the engineers in charge even guess what is happening. But the oil resources of the world are limited too,—and like coal, oil is rich in valuable *bye-products* which are wasted when it is burnt in furnaces. One of the main tasks of modern chemists is, therefore, the discovery of a method by which the valuable bye-products of oil can be extracted without affecting its heating power. Man dare not waste the resources which Nature has given him for nothing.

Another substance on which a great deal depends is rubber. This is extracted from the *sap* of rubber-trees, and is used in many different ways. As we already know it can be hardened into vulcanite, or used as the soft India-rubber which rubs out our pencil and ink marks. It is used as an electric *insulator*, as solid blocks for street pavements, for the soles of shoes, and for a thousand and one other purposes. But its supply is limited and its price is high. Most of the rubber forests of the world lie within the British Empire, and largely in Malaya, so that a heavy responsibility rest upon us in seeing that the supply of this preciou product is preserved and cerefully used. Chemist have already invented many artificial substitute for rubber ; but we cannot afford to waste our resources on which so much depends.

We have often spoken of chemists and the importance of chemicals, and it is now necessary to say a word about Chemistry. Chemistry is the science of finding out all about the various substances of which the air, the sea, and the earth's crust are formed. Chemists study to find out of what they are composed, how they may be changed into other substances, and what happens during these changes. The result of their discoveries has been to place at our disposal vast quantities of resources ; and when one becomes exhausted, chemists set out to discover how it may be obtained from another.

Few people know that sugar, or bright-coloured dyes, can be obtained from black coal —but it is so. Few people know that the lead in lead pencils, and the gleaming diamond, are composed of exactly the same chemical substance ! We depend upon chemicals at every turn. Our food is grown in ground fed with chemical manures : in sickness we depend upon medicines to cure us ; when we have to undergo an operation we depend upon the chemical properties of certain gases to *numb* our senses. One of the commonest chemicals is ordinary table salt, which can be obtained from the waters of the sea, in the same way that iodine, which has saved so many lives, can be obtained from the seaweed which grows along the sea-shore. The climbers upon the hire slopes of Mt. Everest depend upon the chemical properties of oxygen to sustain them and keep them healthy; airships and balloons are lifted by hydrogen and helium which are far lighter than air; and the nourishment of our food depends entirely upon its chemical properties. That is why, when we are ill, we have to eat certain things, and avoid others,—in order to give our bodies the chemical substances which they need in order to work normally. Without chemistry indeed, we should be helpless,—and it is hard to realize that this science is still only in its infancy. Our children and grandchildren will live to see strange wonders produced from the air and the sea, and from the substance of the earth's crust.

We have already spoken of several metals which have been pressed into the service of Man —such as copper, iron and tin. But there are others too which must be mentioned. In recent years scientists have discovered the wonderful properties of a very soft metal called Radium—the rays of whose light will penetrate even the thickest substance. It is used to cure deep-seated diseases which cannot be reached by the surgeon's knife. The story of its possibilities had hardly begun to be written, though it is an exceedingly rare substance and most expensive. A crore of rupees will only buy a few ounces of it; but the healing power of these few ounces far more than justifies the expense. Closely connected with radium, are X-rays,—certain specially powerful light waves, which will penetrate solid substances, and photograph what they find in them. When a man breaks his leg or arm, the fracture can be photographed without his limb being even touched. And many unnecessary operations are now avoided by this new invention. It has become the doctor's greatest aid,—and a whole meal can be followed in its journey through our bodies, as though we were watching a train travelling through a tunnel, while we stood upon the top of the hill!

Other metals which have been much used by Man, are gold, silver and aluminium. Gold and silver have always been used as ornaments, in the same way as precious stones such as pearls and diamonds and rubies. But they have been put to much more important service in the shape of coins. In the early days before the introduction of coined money, men used to trade by exchange—an axe for a joint of meat, a horse for a cow. But that was most inconvenient; and quite early in man's history lumps of stone or wood or iron were regarded as "money" and valued according to their weight. But with the discovery of gold and silver, and the knowledge that coins could be made to take the impression of kings and emperors, they quickly came to be adopted as the normal metals for coins. Since they are of value in themselves there has always been a temptation to rub or chip them, or to put into them less gold and silver than they are supposed to contain. Moreover they are heavy and clumsy to carry about, and so we have now introduced paper money, which can always be changed into gold or silver if we desire. The ordinary Indian ten-rupee note bears on it the words—" I promise to pay the bearer, on demand, the sum of ten rupees" (in silver). And this form of money is far easier to carry about, or to send from one place to another.

Aluminium is mainly useful on account of its strength and lightness. Different aluminium-steel *alloys* are used for the girders and frames of airships and for the wings and bodies of aeroplanes. Aluminium is also used for kitchen utensils and light household furniture, because of the ease with which it can be moved and washed. One day it is probable that we shall use light metals like aluminium, where to-day we are compelled to use heavy metals like iron and steel, without losing any strength. Motor-cars which now weigh more than a ton will then only weigh one or two maunds ; and ships will be able to carry twice as much cargo, as their hulls will be so much lighter.

Another of Man's most important resources which has already been mentioned, is electricity. A hundred years ago it was practically unknown; to-day we feel there is nothing that electricity will fail to do. It can pull a train of one hundred loaded trucks at fifty miles per hour, with the same ease with which it will ring a small bell. It will flash a message across ten thousand miles of space, as easily as it will light a vast city, or measure to the ten-thousandth part of an inch. All that is necessary is to complete the circuit of the current; the mysterious force is ever at hand, and merely by the moving of a switch, man can control all the forces of the unseen, very much like Aladdin and his wonderful lamp.

The name electricity in derived from a Greek word meaning amber. The Greeks knew that a piece of amber, rubbed hard, attracted light substances like straw, just as a fountain pen, rubbed hard against a piece of silk, will attract small pieces of paper. For centuries that was all that was known of electricity: it was an isolated fact that never excited any one's curiosity to enquire further. Another discovery known, but not connected with it, was the *lodestone*; probably some shepherds noticed with curiosity that bits of rocky earth clung to the iron of their shephered crooks.

That was all that men knew about electricity and magnetism. Gradually scientists began to make further observations and our knowledge of electricity grew, although electricity and its mysterious properties were still the playthings of science, its sparks and splutters the toys with which people thought scientists amused themselves.

But the 'amusements' of seroius minded scientists are the foundations on which scientific advance is built. They paved the way for the momentous discoveries of the early nineteenth century. One scientist taught us, after a series of experiments, what now seems to us obvious, that the lightning in the clouds is the same thing as electricity. For years scientists were labouring to prove what they suspected to be fact, that electricity and magnetism were very much the same, and one could be changed into the other. It was the discovery of this simple fact that made electricity such a useful force to man, for our electric motors and dynamos work on this principle.

The field of elctrical research has considerably widened since those early days ; the nature and characteristics of electricity, and the infinite uses to which it can be put, are no longer even the special sphere of scientists. There is no other feature of modern life which is so common or so important. Indeed in recent years it has been discovered that all matter—the earth, our bodies, all solid substances—are not really "soild" at all, but can be split up into atoms, which are in themselves nothing but charges of positive and negative electricity. The nature of each substance depends upon the number and nature of the arrangements of its electrons —or electrical charges. Just as a lump of sugar will absorb water into the spaces between its particles without growing any larger, so all matter contains "spaces" in the arrangement of its atoms, and its properties vary according to that arrangement. Thus copper is an excellent "conductor" of electricity, and electricity will pass along it so rapidly, without causing the generation of heat, that copper wire is universally used for electrical fittings.

On the other hand substances like rubber and porcelain are such poor conductors of electricity that they are used as "insulators." A man wearing rubber-soled shoes can stand with safety on an electric-rail; porcelain insulators are used on telegraph poles to prevent the current from running to earth. Again some substances, like carbon, are such poor conductors of electricity that when an electric current is passed along them they offer great "resistance" and glow with heat; this is the principle of the ordinary electric light bulb. The discovery that electricity can be stored in accumulators, and the knowledge that it can travel along wires faster than thought itself, are perhaps two of the greatest discoveries in connection with electrical development. In this way all the electrical forces of the universe have been placed at Man's disposal, until even the largest ships are propelled by electric motors. and the most delicate instruments are electrically controlled.

Gradually, it seems, all the work of Man will be done for him by electricity. In Western countries people go up and down in electric lifts or on stairs moved by electricity. Bells can be rung, doors opened and closed, clothes warmed, rooms lighted, ships, trains, trams and motors all driven by electricity. Messages can be flashed from one continent to another, or passed along deep-sea cables ; pictures can be transmitted by wireless ; two men may talk to, and see each other, when they are a thousand miles apart. These, and a thousand other things can be done by this faithful servant of man,—that never complains, and never rests, that gives the same service night and day, and the possibilities of which we are still only beginning to discover.

Finally we come to, perhaps, the most important of all Man's resources—the soil of the earth on which he lives. From it he has always raised up food and fruits. From the primitive clearing in the forest with its scattered ears of corn, to the vast prairie lands of Canada, golden-red with wheat as far as the eye can see—is only a stage of development. The principle is the same in each case. Many foods Nature offers us without the need of cultivation at all, but men have found by experience that even wild plants will grow better with care and attention. So the land is ploughed and furrowed, manured and weeded, until it brings forth the maximum crop of which it is capable. The desert heart of Australia will one day be compelled to yield food and sustenance for Man's needs. And however much Man may learn to conquer the powers of machinery or develop the wonders of modern science, he will always be dependent upon his daily bread.

CHAPTER VIII

THE CONQUEST OF POVERTY

In the previous chapters we have looked almost entirely upon the bright side of Man's history, and have examined his achievements in many different forms. We have watched him develop from the frightened hunter in the jungle, to the civilized inhabitant of large towns, with unlimited powers and inventions at his disposal. We have seen him engaged in his struggle to conquer and adapt the forces of nature. We have wondered at the courage and perseverance which has led him on from one conquest to another, and from one invention to another.

But there is another side to the picture which is dark and unhappy. In spite of his triumphs and conquests, Man has not yet learnt to live in sympathy and peace with his fellow-men; he has not yet overcome the problems of government; nor does he yet trust his neighbours. He has pulled down the forests, and spoilt the beauty of his world, building instead towns and cities which are full of disease, poverty, ugliness and unhappiness. Every country in the world spends large sums every year on building shells and guns, and on defence, while so many of its people live in conditions of poverty. This money could be more usefully spent on food and houses and clothes.

The world of natural beauty of Man is rapidly turning into a world of ugliness and disappointment. "Speed," "Pleasure," "Progress"—these are the mottoes of modern civilization ; and the grim figure of poverty lives in our homes and streets, as a reminder that Man is not yet the conqueror he pictures himself to be. There are to-day in India, and in nearly all the countries of the world millions of men unable to find work. The failure of the monsoon, an outbreak of floods, or the spread of some terrible disease, can produce a harvest of human misery almost impossible to believe. Between 1914 and 1918 more than ten million lives were lost before men began to understand the folly and crime of war ; yet to-day the Armies and Navies of the world are bigger and more destructive than ever before. Men still poison one another with gas, or blow one another to pieces, because they have not learnt the arts of peace. These are the dark shadows which hang over the records of Man's history and compel him to face the truth of his own failure. Inventions, discoveries, power,—these are but the toys with which he plays. The real road to his Conquest he has hardly begun to tread ; and the way is long and steep.

In this chapter we shall only deal with one aspect of Man's failure—the problem of Poverty.

When we speak of Poverty we generally mean lack of money, and of the things which money will buy. Far too many men and women are compelled to work for wages which are insufficient for their needs, and under conditions which destory health and happiness. In India the labour of women and children is still unfairly used, because it is cheaper. In the big cities of the world, people are obliged to live in restricted space, sometimes as many as eighteen in two small rooms, hardly able to keep body and soul together. The more men who need work the lower wages become ; the lower wages become, the greater the number of those who are faced with starvation. But this is not a problem which can be solved in a moment. It is the fault of nobody in particular. It is merely that we have never given the same enthusiasm and concentration to the solution of these problems, as we have given to the invention of a new engine or aeroplane.

But even now it is already recognized that every citizen of every state has a right to be comfortable. It is reckoned that in England in the eighteenth century, eighty out of every hundred people were poor ; that is to say, they had no certain means of livelihood, they could not afford two meals a days, or even clothe themselves properly. The number of such people is not so large to-day. Laws have been passed which make it certain that everyone who works in a factory shall be well looked after by his employer. Better houses are being built : the factories are well lighted and ventilated : the hours of work and a minimum wage are fixed. Mereover, for those who work in dangerous industries, such as coal-mining, special provision is made.

Again all emyloyers have to insure their workmen against death or accident; the State insures everyone against old age ; those unable to find work are given temporary help every week until they can find employment. As a further instance, far more is being done in India than ever before to help those who are unable to help themselves. The misery which used to follow a famine or failure of the monsoon a hundred years ago, is now no longer possible. There are canals to guard against uncertain rainfall. The means of transport have been developed to carry food from one part of the country to another. The Government has special funds to deal with famine and plague and floods and locusts. It is no longer necessary for men to sell their children or to through them on the roadside. They need no longer live on dung, on roots of trees, and on dried grass, as has often happened in the past.

One way in which nations can fight against poverty is by increased agricultural production. A scientific study of soils is made to find out how they can be made to yield richer crops. Manures and chemical foods are put into the ground to increase the harvest. It has been estimated that in the sixteenth century an acre of land produced only six bushels of wheat; now under scientific cultivation it yields more than thirty. Indian agriculture is still in its primitive stages, but the Agricultural Council set up by the Government of India will do much to encourage progress, by improvement of seeds and manures and cattle, until the plains of India will become a great storehouse of wealth. It is true of course that there will come a time when all the land in the world will be under cultivation, and no increased production will be profitable. Then the scientists will be faced with the problem of discovering new foods which will not depend upon the soil. But that time is still very far distant; and the vast irrigation schemes of India alone will bring under cultivation millions of acres of unused soil.

The need to produce more food was never greater in India than it is to-day. India must produce all the food she requires, otherwise she will be faced with great difficulties.

Already there is much less poverty in the world than there has ever been before, and a special science called Economics has grown up, partly to deal with this very problem. There is no reason whatever why machinery should mean human unhappiness. Men like Henry Ford have shown that it is possible to employ thousands of men in good factories, on high wages, working short hours, and still to make a good profit. His men are paid a minimum wage of fifteen rupees a day, and they work only for five days a week. So they have money and time for pleasure and recreation. In America many factory workers drive to work in their own cars. In this way men are using machines to increase their happiness; through them they become not slaves but more free.

But this is the bright side of the picture. Only too often factory life is dirty and unhealthy. It ties men and women down to low standards of living and banishes all pleasure and happiness from their homes. The slums and tenement-houses of any large town are the biggest blot on civilization. We have learnt how to build battleships and aeroplanes, but we have forgotten how to build houses. We are in danger of becoming slaves to our own inventions, and of forgetting the right of every individual to a free and happy life. "Service," not "Profits" nor "Selfishness," must become the watchword of industry; a man's right to a fair wage under fair conditions must become something which every employer will willingly give, instead of something which can only be obtained by strikes and bitterness. Men must learn again to take a pride in their work, whatever it be, and so again pleasure from doing it well. When every member of a country can feel that he is contributing his full share to his country's prosperity, and receiving his full share of happiness in return—then indeed we shall have gone some way towards the Conquest of Poverty.

Up to the present we have dealt entirely with the point of view which regards "wealth" as money, lands, property, material prosperity of any kind. But this is only half the truth, Happiness does not consist in riches, although it is very easy to believe that it does. True wealth would be much better defined as "character" ; for a man can only be happy when he is at peace with himself. The richest men are very often the most unhappy, since they do not realize that a man's wealth does not consist in the abundance of things which he possesses, but in the sort of a man that he is. The Greeks wrote over the entrance to one of their most famous temples the words—"Know Thyself." They understood that in order to be happy a man must face life honestly. He cannot expect to "get" if he never "gives", he cannot expect to be happy himself, if he never makes others happy A man's life is of no importance or value at all, unless he succeeds influencing, helping, and encouraging those among whom he lives. For too many people are not 'living' at all but are just 'existing' for themselves alone ; they receive no happiness from life because they never give happiness to others. In other words they are poor in spirit ; for there is a spiritual side to poverty as well as a material. A man can be rich on twenty rupees a month, if his mind is trained to seek happiness in human friendship and companionship and helpfulness, instead of in money.

For this reason every nation wages war against ignorance—because ignorance means poverty. Education has long been compulsory in the West, and is slowly becoming so among the millions of India. Education of course does not mean learning for examinations as many people in India seem to think; it means gaining new interests, storing up new wisdom, learning to become a useful and happy member of society. Education is a complete failure unless it gives a man something deeper than a knowledge of a few text-books. Unless our education makes us better men and women than we should otherwise have been, then it is an expensive failure. For all the knowledge in the world will not make a man happy, unless it has given him, as well, a knowledge of himself. In fact, we each have to learn that we have, responsibilities' as well as 'rights'. We cannot expect everything for ourselves and nothing for others. If we allow our compound or house or street to remain dirty, disease, through our carelessness, will spread unhappiness and death amongst our neighbours; and if we deny happiness to others, what right have we to happiness ourselves? Education teaches us to be healthy and responsible citizens, to use our brains and bodies in the right way.

To conquer ignorance is therefore to conquer poverty. Every year millions of pounds are spent upon education ; yet the total of human misery remains terribly high. Here is a field for conquest, far more glorious and far more profitable than the conquest of machines—Man's conquest of himself.

CHAPTER IX

THE CONQUEST OF DISEASE

Another of the problems with which man is faced is that of disease. Between the witch doctors of Africa and the modern specialists in medicine and surgery, there is a difference. But even now in many villages of India disease is believed to be caused by the anger of gods and goddesses. Whenever an expedition advances into the higher Himalayas, the Tibetans believe that the mountain gods will become angry and will take their revenge on the people who live below them. A man will allow dirty stagnant water breeding mosquitoes to lie near his house, and yet will blame providence or *kismet* when he gets malaria. So terrible is the lack of knowledge and superstition that out of nineteen thousand babies born every day in India, more than five thousand die within a month. So far as it is possible to tell, more than two million babies die every year. The average *expectation of life* in this country is less than thirty—while in western countries it is over sixty. The ancient systems of medicine have been neglected, and the new western methods are not yet practised, except in large towns. The result is a very high death rate, terrible suffering due to ignorance, and the general misery which results from the constant attacks of disease.

But there is no excuse for us to suffer any longer. It is lack of education, not lack of scientific knowledge, which causes much of the world's suffering. Four hundred years ago men did not understand what the plague was; so terrible and so sudden were its attacks that the only satisfactory explanation was to regard it as caused by the anger of God. Even to-day when some particularly terrible accident or disaster takes place we often call it "an act of God." The only possible remedy for the plague was to run away from it. Infected houses were marked with a cross; the dead were thrown naked into the streets for burial; and carts collected them during the night. Sometimes half the population of a country would be wiped out. For generations, even in Europe, disease was regarded as a natural punishment of sin. Later when a more scientific view of disease became accepted, doctors tried to cure it by better sanitary conditions in houses and streets. They did not know the cause of disease; they only knew its symptoms, such as dirt and superstition. They tried to cure it; but they did not know how to prevent it.

Of course to a certain extent there is sound commonsense in offering prayer to a god or goddess. For we are learning more every day how much a man's mind may control his body. Pain and suffering are largely connected with the mind, and they can be largely controlled by it. A man may smile in great agony and by so doing his pain will be lessened ; or a man may imagine that he is unwell and very soon he will actually feel ill. As was said in the last chapter, the first need is for man to know himself. Quite a considerable amount of good can be obtained by merely saying ten times every morning—"I am becoming stronger and healthier and happier and better everyday." This is not just nonsense, but scientific fact ; an idea once held by the mind will quickly affect the body. Imagine for the moment that you are eating lemons ; they are sharp and bitter and sting the tongue. Almost immediately your mouth will begin to water ! Allow yourself to think that you are tired, and at once you will begin to feel weary. Make an effort in your mind to be cheerful and happy, and your body will respond. One half of the secret for the conquest of disease is therefore man's knowledge of himself.

But that in itself is not enough. He must be supported by careful scientific research into the causes and nature of disease, with a view to finding a preventive or cure. This investigation began with the discovery of *bacteria* by the French chemist, Pasteur. Before his time doctors had suspected that disease might be caused by the presence in the human system of poisonous germs. But as they could not explain how they came to be there or how they could be removed, their brother doctors laughed at them as though they were no better than the African witch doctors who believed in ghosts and evil spirits. It was the discoveries of Louis Pasteur and of the men who developed his theories, which established beyond doubt that diseases are caused by bacteria or germs.

Louis was born in 1822 in a small French town. His father, who had been a soldier in Napoleon's army, was keenly interested in his son's education. He even hoped that one day he might become a Professor at one of the big colleges in Paris; and this ambition was fulfilled in a wonderful way, for Louis Pasteur became the most famous Professor of his day. One of Louis' earliest presents was a small *microscope*, and with this he began to examine specimens of beer and milk and wine, to try and discover why they sometimes became 'sour' when exposed to the air. By patient experiment and observation he discovered the fact that the presence of germs in these liquids caused a chemical change, which turned them sour. And then by a long process of experiment he was successful in isolating different germs. Hard work was the ideal of his life and although he lived to the age of seventy three he retained all the vigour of his youth until the end. We owe to him the discovery of the germs of rabies and cholera and anthrax. He founded the famous Pasteur Institute in Paris, where treatment for rabies was first given. Now every civilized country in the world has a *Pasteur Institute*, where hundreds of lives are saved from this fatal disease.

But perhaps his most important discovery was the principle that disease is carried from one individual to another by germs. He tried his experiments on rabbits and guinea-pigs, and showed how the presence of germs caused disease in all living beings. With this knowledge he was able to save France from a terrible disease among her silk-worms, which was running her famous silk industry. At first of course very few people believed in his discoveries or understood them. But they set the medical world talking, and other men took up his work where he laid it down. His was really the first great step towards the Conquest of Disease.

It is true that even before his time considerable advance had been made towards modern surgery and medicine. *William Harvey*, as early as the reign of Charles I, had discovered how the blood circulated through the body. He studied at foreign universities and put forward his new theory that the heart, when it contracts, forces the blood through the veins and arteries of the body. Charles I himself was much interested, and there is a famous picture in which Harvey is seen explaining his theory to the King. It was the first step towards a detailed knowledge of the human body and how it works.

After him there was a gap of nearly a hundred years, until the work of *John Hunter*, who studied the structure of the human body and founded the modern science called *Anatomy*. His work in turn was followed by that of *Edward Jenner*, who introduced vaccination. He had studied under Hunter, and then devoted himself for twenty one years to a careful study of small-pox. He hoped to be able to prepare a vaccine which would drive small-pox out of the world. With great bravery he tried his discovery on himself and his own family and so initiated the principle of vaccination and inoculation. At first his theories were hotly opposed; but news of the discovery was carried throughout the world, and the English Parliament gave him a grant of £30,000. We have only to think of how much pain and suffering have been avoided in India alone to realize the importance of his work.

Everything was now ready for a great advance in medical and surgical science. Surgery itself is more than five thousand years old. But even as late as the beginning of the nineteenth century all operations had to be performed while the patients were conscious and could feel the pain. Many lives were lost simply because men and women were unable to bear the agony, and many died because their wounds would not heal after the operation. For the solution of these problems two men are responsible. Sir James Simpson was born in 1811 in a small village in Scotland, where his father was a baker. But in spite of his humble circumstances his father determined that he should have the best possible education. He was sent to the best school in the district, and later to Edinburgh University. At the age of twenty-one he became a doctor, and at once developed a keen interest in surgery and operations. He was anxious to find some means of numbing the patient's senses so that an operation might be performed without pain. He had heard of experiments with a liquid called 'ether' and he tried its effects upon himself and upon his friends. But it did not fulfil his requirements, and inspite of much patient work he was disappointed, until he found a small bottle, which had been given him some years before, containing a liquid with a very powerful smell. With two medical friends, who shared his interest and enthusiasm, he determined to make a last attempt. Sitting round a table they all three began to breathe the vapour of this liquid.

What a dramatic moment that must have been! At first they became most lively and excited and talked a great deal; but slowly a drowsy sleep fell upon them, and there was silence in the room. They did not know for how long the effect could last; they were not even sure that they would ever wake again. But in the cause of science they were prepared to take the risk, and their courage was justified when Simpson later woke from this sleep, entirely unharmed. Sometime afterwards his friends woke too, and congratulated each other upon the discovery. The same experiment was tried upon a niece of Simpson's who recovered with equal ease, and in this way chloroform was given to the world. From this moment operations, which had been impossible before, could now be performed; and an almost incredible amount of pain and suffering was spared to the human race. It has been followed by the discovery of many other *anaesthetics*, some of which only numb the actual part of the body on which the operation is to be performed. But the principle, first discovered in the lonely silence of that little room in which three men risked their lives, must be entirely credited to Simpson.

One other great problem remained. However painless and successful the operations were, it was still found that a very large number of patients died from their effects. This problem greatly interested a young English doctor, whose father had had much to do with the invention of the microscope. When, as a young house-surgeon, Lister went into a London hospital, he was much worried by the number of deaths among those who had undergone an operation. Though the operations were generally successful, from a surgical point of view, the wounds became sceptic and very few survived. The doctors were in despair, because in spite of the greatest care and cleanliness they could not prevent the wounds from becoming sceptic. Lister realized that the trouble was caused by the presence of germs in the open wound, and set out to devise a method by which they could be attacked and killed.

He realized that the germs could not come from the wound itself, but must have been carried there, and at first he tried to exclude the air from the wounds. By a series of experiments he came to the conclusion that anything which touches a wound, from the surgeon's knife to the bandage and dressing with which it is covered, may be a source of infection. So he laid the foundation of modern surgery in which every thing is sterilized, or boiled, and so made free from germs. The great secret is to allow no germs to enter the operating theatre at all. The doctors and nurses wear sterilized clothes and gloves and they breathe through masks which sterilize the breath; every instrument and dressing and bandage has been thoroughly sterilized before it is used. It is impossible to estimate the millions of lives which have been saved by this simple discovery. The whole work and methods of hospitals have been completely reorganized and now it is the exception rather than the rule for a patient to die from the effects of an operation. All the wonderful cures performed by the surgeons of to-day would have been impossible but for Lister's devotion to the ideal which he set before himself in his career. At the end of the nineteenth century it was said, that his discovery had saved more lives than all the wars of the century had sacrificed!

But even when it became known that most liseases were caused by germs, it was not easy o find out the nature, the habits and the "carriers" of these germs. For long it was not ossible to trace the cause of malaria, because t could not be discovered how germs were arried about. *Sir Ronald Ross* spent years of atient toil in India, Burma, and Malaya before e discovered the existence of the "Anopheles" nosquito. This mosquito sucks up the germs f malaria from an infected patient; they breed n its body in large numbers and when it next tings another person, the germs are lodged in is blood. The cure for malaria is therefore the revention of mosquitoes. Many parts of the orld, in India, Africa, America and the East ave been made inhabitable by this simple iscovery.

The work of scientists like Ross is carried n with great sacrifice both of men and of noney. Dr. Koch of Germany worked in his boratory for fifty years in order to finish the ork begun by Pasteur. He discovered the erm which caused consumption, and suggested cure for it. He went to Egypt to study holera; he came to India to enquire into the ause of the plague which is carried by rats nd vermin; it was a Japanese pupil of his who iscovered the germ which causes bubonic lague, the deadliest form of a deadly disease. e himself risked his life in the forests of East frica in an attempt to find out all he could about sleeping sickness, which is caused by a fly. Once the cause of a disease becomes known, the minds of scientists set to work until they can find a cure. A new science of bacteriology has grown up in recent years which deals with infectious diseases, their prevention and cure. The bacteriologist has invented vaccines and serums, and by injecting a small dose of poisonous germs into our bodies he causes the blood to fight against them, and so we are able to repel the attack of the disease itself when it comes. There are even cures for the bite of a poisonous snake for those who can reach a hospital in time. All this has followed from the work of Pasteur, and of those before and after him who have given their lives to the study of disease.

In the last chapter some reference was made to the evil and folly of war, and the misery and unhappiness which it inevitably brings with it both for victors and vanquished. Men with their nerves shattered, and their bodies torn, broken and disfigured, are left to the mercy of a world which has no use for them. As fast as man learns to overcome and conquer disease he creates new realms of suffering by his own folly. How pathetic it is that the greatest triumphs of surgery and medical skill are displayed in the efforts to patch and repair the bodies of men whom their fellow-men have blown to pieces! But it must be admitted that medical science and nursing owe much to the lessons of war. In the *Crimean War* about the middle of the nineteenth century, it was an English women named *Florence Nightingale,* who first taught men that suffering may be much relieved by the skill and tenderness and care of women. She organized hospitals; she insisted on cleanliness and care and comfort; and after the war she carried her experience into ordinary life. Civil hospitals were built all over England; nursing associations were begun; every civilized country followed England's example. There is scarcely a town or district throughout the civilized world now which has not its own hospital. Within their walls the skill of doctors, the devotion of nurses, and the wisdom of science, are used to decrease and lighten much of the world's suffering and pain.

By the wonders of modern surgery, the human heart can be removed from the body for treatment and then replaced; the most delicate operations can be performed upon the brain; limbs and features can be artificially made and grafted. By the discovery of the powers and properties of radium many deep-seated diseases can be cured by external treatment. Our bodies can be photographed until every detail is plain to see; broken and diseased minds can be restored to sanity and happiness; deadly diseases like cancer and leprosy and paralysis are slowly yielding up their secrets to the patient and constant experiments of scientists. The day will come indeed when men need suffer no more and when science will have conquered disease.

But this fact should not blind us to the unpleasant truth that by far the greatest part of the world's suffering is caused by man's own folly and sin. The torture of poverty; the wretchedness and misery of our modern towns; our lack of faith in the beauty and value of human personality,—these are the grim figures which ride the clouds of man's history. They will never be conquered or overcome, until the miracles of science are no longer required to undo the follies of men.

CHAPTER X

THE CONQUEST OF BEAUTY

From the beginning of this book we have been thinking of Man's conquests and triumphs in the world of material things. We have watched his attempts to conquer nature, to persuade her to give up the secrets of her laws and principles, so that they may be adapted and transformed to Man's needs. We have learnt something of the wonders of modern inventions and material progress. We have seen him advance from the frightened creature, afraid of the world in which he lived, to the conqueror of the land and sea and air. In the last two chapters we have seen him struggling with problems which are in a large measure beyond his power, mainly because they are spiritual or mental and not material. Just as the highest mountain peaks are safe from the tread of man's conquering feet, so there are whole departments of his life in which he has to confess that he is still an ignorant beginner—a failure. While his boasts of civilization and progress fill the air, they are almost drowned by the cries of the millions for whom civilization means misery, disease and death. The road of man's history leads upwards, ever upwards, and he is faced with new difficulties and problems every year.

In this chapter we shall face more clearly one of the problems which it has always been man's desire to overcome, and whose solution he has still not found. From the very earliest days the desire for beauty has been universal. Encouraged by the wonderful loveliness of the world, man has always tried to brighten his life by an attempt to conquer beauty. The earliest caves and homes had rough pictures on the walls which appealed to his sense of beauty. Even the most primitive tribes and races know the advantage of colour and decoration; the poorest Indian villager loves to dress himself in bright colours ; the temples of all religions from the very beginnig have been made beautiful with paintings and carvings. In other words Man has always recognized that the happiness of life depends not only on material things, but also upon the contentment and satisfaction of his mind. Imagine for a moment what our world would be like without colour, without the soft shadows of the clouds, the shade of a green tree in the heat of summer, the beauty of flowers, the colours of a sunset, or the deep blue of the sea. One of the greatest punishments with which man can be faced is blindness, because it shuts out from him the natural world of beauty which is a constant source of pleasure and encouragement.

To each one of us beauty means something different. To one it may be the white snows of the mountain peaks as they catch the last

rays of the setting sun, to another it may b
the shadows of a green hillside, to another
rushing river or a book or picture. One ma
may see no beauty in a sunrise, but may lo
the design of an engine or machine. One ma
love the bright colours and deep shadows
the world at midday ; another may prefer th
quiet peace of a moonlit night. In other wor
we can only appreciate beauty when it cal
forth a response from something within ou
selves.

Nor can beauty be confined to materi
things ; the search for truth, a brave action,
kindly thought, an unselfish deed, are in them
selves beautiful. For this reason the ancien
Greeks believed that Truth, Beauty and Goo
ness were the three things which mattered mo
in life—and they recognized that no life coul
be beautiful, which was not at the same tim
true to the highest ideals. In the hurrying day
of this century we have almost forgotten thi
fact, and we expect to find beauty where n
truth nor goodness is. Because of this weaken
ing of our own sense of beauty, we are eve
destroying the natural world around us, an
replacing woods and flowers and open countr
with machines and buildings.

But in his longing for beautiful things, ma
has achieved much that is worthy of praise
and much that has endured the test of th
centuries. A useful machine, or a powerfu
engine are only temporary things : but "

Thing of Beauty is a Joy for Ever." An Englishman once wrote a poem "To a poet a thousand years hence", because he knew that the beauty of poetry would survive even a thousand years, while kingdoms decayed and civilizations crumbled into dust. In many parts of the world men are digging up the vanished cities of the past, and gaining from them a new conception of beauty. The cities have vanished, but the spirit of beauty which lived in them remains alive.

Indeed it is true that the most lasting form in which man expresses his love of the beautiful is in buildings. When he lived in mud and grass huts, he built a shrine for his gods far better than that in which he dwelt himself. Upon his home he later learnt to bestow much greater care, although it has always been true that his temples and mosques and *cathedrals* have absorbed far more of his skill and patience than his own home. This is proof that the love of beauty is a deeper thing than man's own selfish needs. In the Middle Ages, when men were terribly poor, they built magnificent places and churches just for the joy of creating things which were beautiful in themselves. India is particularly rich in buildings of this kind ; the wonderful Hindu temples of South India, the Taj Mahal at Agra, Akbar's dream city of *Fatehpur Sikri*, the gardens and tombs and palaces of the Moghuls, are all evidence that men hunger to express their love of beauty in bricks and stones and marble.

The Taj Mahal is indeed one of the most beautiful illustrations of this desire. It is beautiful not only because of its loveliness—and it is often considered to be the most beautiful building in the world—but because it was built in memory of a great love which endured beyond the grave.

To-day the Taj Mahal is an object of pilgrimage from all corners of the earth. Poets have sung its praises; artists and photographers are never tired of capturing its purity and grace; hundreds of new admirers are added daily to the countless thousands who have visited it since 1650, and have taken away with them the memory of a lovely dream expressed in white marble.

At dawn the cold gray shadows slowly lift as the first rays of the sun catch the dome and minarets, and the mists rise from the Jumna. For a moment, perhaps, its whiteness is tinged with rosy pink, and the grey shadows pale to blue; then gradually the pink shades fade, as the sun rises above the horizon, and in the silence the dazzling vision of loveliness is born again. At midday the sun shines fiercely, and the intensity of its whiteness is so great that men must veil their eyes. Later, the soft deep shadows of evening give way to the rich colours of sunset, reflected in the waters of the Jumna, which catches the image of the tomb to its bosom as though anxious to retain for ever the reflection of its loveliness. And then night hides the garden in its fold, so that the Taj is but a soft glow in the darkness, or a dream of snowy loveliness in the moonlight.

No number of visits can ever break its spell. The beauty and peace and flowers of the garden; the cypresses and pools which direct the footsteps of the pilgrim; the sense of calm and restfulness, and the crowning glory of its loveliness—more beautiful than words can express—are an exquisite memorial to the tenderness and permanence of Love. Like the soft echoes which gather strength in the shadows of its dome, it grows in loveliness—the most perfect expression of the grace and purity of woman that the world has ever seen.

Probably as old as architecture is the science of painting, used by Man to decorate his house and temple and buildings. From the very earliest days men have expressed their love of beauty in this way. The Elephanta caves, the ruined cities of Egypt, Crete, India, Greece and Rome, all bear witness to this, in the form of drawings, and paintings on the walls, and coloured pottery. Later painting took the form of coloured designs on wood or canvas (as we know it to-day). The West is famous for the beauty and number of its paintings; and in the East the lovely *miniatures* of the Moghuls and Rajputs, the delicate pictures of Japan, and the lovely colour-sense of China, are evidence that the love of painting is universal. But to-day the world is in some danger of losing the art;

photography and the cinema, though they are often beautiful in themselves, are no substitute for the skill of the artist's brush. And the world will have paid a heavy price if it has gained one at the expense of the other.

Closely connected with painting are *sculpture,* carving and pottery. These depend more upon shape and line and form, than upon colour. But they have many advantages because they are not so subject to the influence of climate, and are more permanent. The carvings and screens of Indian temples, the beautiful statues of ancient Greece, the wonderful Buddhist carvings at *Sanchi*, and the treasures which are unearthed whenever men explore the buried cities of the past, are proof of Man's desire to express his love of beauty in wood and stone and pottery.

Not all expressions of beauty are silent. Speech and language are at least as old as any other branch of art. In the very earliest days men learnt to standardize their sounds, and even to invent symbols for them in writing. Language and literature have always been the easiest means of expressing a people's thoughts and feelings. We are inclined to forget that language is a. beautiful thing in itself, quite apart from its usefulness; and it is easy to neglect the importance of great writers in shaping and influencing man's history. The power of speech and the written word are, indeed, probably the two greatest influences for good or evil, in the world. Every people and nation, since time began, has had its own language, even if it was no more than a rough system of signs and symbols. Nearly every nation, at some time in its history, has produced great literature. The Vedas of India, the poems and legends of Persia and Arabia, the plays of Shakespeare, the philosophies of Greece and China are only some of the most important examples.

One other major branch of art still remains to be considered, that of Music. It has always been closely connected with speech and at the same time it has always been the means of expressing those emotions which are too delicate for the spoken word, and too deep for the pen. Music is most intimately connected with the two emotions of joy and sadness; and this seems to have been true all down the ages. The wild music of a wedding dance and the sad notes of a funeral march are symbolic of all that music represents. It is often accompanied by dancing and singing, which are also in themselves profound expressions of human emotional experience. But a true love of music is perhaps less common than appreciation of any other form of art ; and in these modern days of noise and progress we are in danger of losing it altogether.

We have now faced the fact that there are whole departments of life which cannot be valued by material standards. They are expressive of man's spirit, no less than his search for truth or his love of adventure. In a chapter so short an this it has been impossible to do more than sketch a few lines of this picture of man's other self; and even these few lines are incomplete and out of proportion. But man is a spiritual being fired with emotions and ideas and hopes which cannnot be confined in wood or stone or iron. He lives in a world which flings its beauty at his feet. He himself is always conscious of the need for something deeper than mere material prosperity. For this reason therefore no review of his achievements would be complete which did not glance at his journey in this world of the spirit, and indicate how far he may claim to have become the conqueror of Beauty.

CHAPTER XI

THE INSIGNIFICANCE OF MAN

In speaking of Man's achievements down the ages, it has been easy to adopt a tone of pride and congratulation. His difficulties have been so enormous and his conquest so widespread that no other attitude seems possible : the ways in which he has shown his powers and his creative intelligence are almost beyond praise. But such an attitude places man in an entirely false position.

The age of the earth on which we live is probably two thousand million years (2,000,000,000) and the age of telescopic *astronomy* is only three hundred (300) years. How little then we should expect to know of the vast universe of which we are a part ; and how hard to understand is the little which we do know already ! For instance, there are probably well over, three hundred thousand million stars. (300,000,000,000) of which the human eye can see about three thousand ! That is, for every man, woman and child on earth there are over two hundred stars in the universe ! The earth on its yearly journey round the sun is travelling at a speed of 18 ½ miles per second, or 1200 times the speed of an express train ! Yet our earth is so small that if a photograph of a cluster of stars four inches square were given to you, it would have to be enlarged to the size of the whole of Europe before a body so small as our earth would become visible! Or to explain it in another way: if you can imagine the distance of the earth's journey round the sun reduced to the size of a pin's head, —then on that scale the nearest fixed star would be 225 yards away, the *milky* way would be the size of the American Continent, and a model of the whole universe would stretch for four million miles in each direction!

Each new secret of the universe illustrates the insignificance of Man. What if in this vast immeasurable universe, man is the only creature endowed with a spirit; his the only world with life upon it! What strange loneliness in a Creation that has neither a beginning nor an end! And if he is one of many other races of intelligent beings on other worlds, again how strange that he should know nothing about them, and be for ever cut off from them! How easy it would be to think of Man as only one of many animals—a strange mysterious being, with an unknown origin and an unknown end! With this great problem all the religions and philosophies of the world have been concerned from the beginning even until now; but on this point, at least, they are agreed, that there is a Purpose in the universe in which Man has to play an important part. His destiny is reserved for him in the Heavens.

Nature guards her secrets very jealously. After centuries of toil and discovery, man still knows only a very small fraction of what there is to know. After centuries of attempts to master the forces of nature, they are not yet fully tamed or harnessed. Her power to destroy the work of man remains supreme. She has volcanoes still; they can send forth their lava to burn his cities as fiercely now as they did ten centuries ago. The earthquake, in spite of the invention of the *seismograph*, which registers the slightest tremor of the earth, remains even to-day a force before which men flee away in fear. Fire—that great friend of man—can still destroy as rapidly as of old. Floods may sweep away the labour and work of years. The thunder and the lightning are still beyond the powers of man to control. Rain and wind, heat and cold, even though they can be explained and analysed, are not yet subject to his power. Life and death, Happiness and Pain, the Nature of God and of His Universe, the meaning and purpose and value of Life—these are still hidden in the mists of uncertainty. Before the vast unknown—that country whose shores the feet of men have never trod, and behind whose still-closed gates there rest the Everlasting Truths,—man is but a little child, praying on his knees that he may one day be permitted to know all.

And while he prays, while he seizes proudly and gratefully each new aspect of truth, captured from the secrets of the Universe, his enemies multiply about his gates. Each new discovery brings with it some fresh danger. Man conquered the air, and his inventions have been turned against himself, so that the skies rain bombs and fire. He has learnt to ride the seas, and the terrors of destruction sink his largest ships. He boasts proudly of his wealth and power, and every hour men die of starvation and poverty. He proclaims his conquest of health and happiness, and cries of distress and pain from countless beds of illness and disease drown his boast. He has invented machines to do his work and to provide his pleasure ; he has climbed the heights of invention, and searched the lowest depths of Truth. And yet the door of his achievements has opened so very little that he can scarcely see into the infinite unknown that lies beyond.

But he cannot afford to lose interest, or to lay down his weapons, and survive. He has been a fighter and he must remian a fighter—struggling to claim and to make his own, the secrets of the universe in which he lives. Nature is still unconquered. She has yielded up small parts of knowledge, here and there, and men takes pride in his conquest, as if that were all. But her deepest Truths remain unconquered, and the true men of science know it. She holds her secrets still, to which a solution will be found only by patient and unceasing labour. Man is still a mystery even to himself, his mind perhaps the greatest mystery of nature.

Expeditions, like those to Mt. Everest, are symbols of this struggle. There in the distance stands the lonely peak inviting formidable, incredibly fascinating. Its approaches are guarded not only by altitudes where oxygen is rare, and where men can only breath with difficulty, but they are surrounded by glaciers and steep ice-slopes, amidst the piercing winds and blinding snow of mountain storms. Man knows all this, and remains unshaken in his resolve. Every year he pushes forward; from 22,000 to 24,000 feet; from 24,000 to 28,000—until the summit one day will stand beneath his feet. Nothing is achieved save the gain in Man's resolve; nothing is won save the heightening of Man's spirit. "As Sir Francis Younghusband puts it very well, : Everest cannot add to her height; but the spirit of man heightens under every repulse." This gradual heightening of the spirit of man has made him what he is, and it will achieve for him what he will yet become.

He has shown by his achievements that he has within himself the seeds of his final triumph. Every day he adds to his knowledge, his experience and his determination; as the problems multiply, so does his courage increase. As the shores of knowledge seem to fade into the distance, so does he launch into deeper waters. Although the heights of Truth escape the vision of his eyes, still he plods his lonely road. Inch by inch he pierces into the unknown; inch by inch he strengthens the ground of truth below him. What final heights he will achieve are left to the imagination; but he will always be faced with new worlds to conquer. Perhaps Nature will guard her closest secrets to the end—Nature unconquered and unconquerable.

NOTES

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2.	**An unsolved mystery.**	From the Anthropoid Apes, who seem to reason and think, and to communicate their thoughts to each other, the jump to Man is a big one; but it is no harder to understand than the wonders of Man's physical development from the lower animals.
7.	Marco Polo.	(1254-1334) An Italian traveller, who wrote a very interesting account of his travels in India and the Far East. He even climbed some of the higher ranges of the Himalayas, and described the Marco Polo Sheep, an animal which was not re-discovered until a few years ago.
„	Drake.	The most famous of the Elizabethan seamen. He was the first Englishman to sail round the world (1557—1580). He was responsible for many daring attacks on the Spanish fleet, and on the Spanish Main.
„	Livingstone.	One of the great explorers who journeyed into the unknown heart of Africa.
„	Amundsen.	Famous for his many expeditions to the Arctic and Antarctic.
„	Sledges.	A framework based on 'runners' of wood or steel, used instead of carts over ice and snow. They are often drawn by dogs, as well as by men or horses.

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9.	**Stratosphere.**	The upper atmosphere above the earth. As we rise higher above the earth, the pressure of the atomsphere decreases, and it is believed that it finally disappears altogether. American airmen at present hold the record for a flight in a balloon into the stratosphere, having risen to a height of more than1 3¼miles.
9.	Herschel.	Sir William was born in 1738, and died in 1822. He added much to the knowledge of the Solar System, at a time when very little was known of it.
11.	**The Yak.**	A hairy animal, rather like the camel, whose sure foot and great powers of endurance cause it to be used as a beast of burden in the mountainous areas of the East.
12.	**Motive-power.**	The kind of power which moves any moving thing. The motive powers which moves a man on a bicycle is his own legs. The motive power of a train is stream.
14.	**John Cobb.**	Holds the world record for speed on land, having travelled at just over 368 miles an hours, in his car on Daytona salt flats in America in 1938.
,,	**Richard Trevithick.**	(177-1833). It was between 1786 and 1801 that he invented a steam-carriage, which ran from Cambourne to Tuckingmill It was taken to London in 1803, where it made successful runs.

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		The development of high pressure steam engines was largly due to him.
19.	The Romans.	Founders of one of the great civilizations of the world, based on law and militarism, which lasted from about 400 B.C. to A.D. 400. The out-post of the Empire, at the height of its power, extended to include all Europe, Asia Minor, and the North-African Coast. When the Empire passed sway its influence remained in a system of government and discipline wherever it had held away.
20.	Telford.	Thomas Telford (1757—1834) He was responsible for the building of more than a thousand miles of roads, and over 1200 bridges during the twenty years from 1803—1823 when he was at the height of his fame.
,,	Macadam.	John Macadam (1756-1836). He rose to be the Surveyor General of Roads, and his 'macadamized' roads became popular because he made them cheaply and well.
23.	Canoe.	A light boat formed by hollowing out of the trunk of a tree.
24.	Paddle.	A light piece of wood, specially shaped, used to push a boat through the water.
,,	Keel.	The central piece of the bottom of a boat. In the days of wooden boats it was made of the trunk of a tree, but now it is made of steel.

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,,	Oars.	Long paddles, which can be used by more than one man, thus increasing the power of each stroke.
,,	The Vikings.	Brave seamen from Northern Europe, who commanded the European seas from the 8th to the 10th centuries, and frequently attacked the shores of neigbouring countries, especially Britain.
,,	Norsemen.	Men of the North—a name often given to the Vikings.
24.	Fragile.	Delicate, not strong, easily broken.
25.	Phoenicians.	Inhabited the coast-line of Palestine and founded an Empire whose prosperity depended entirely upon sea-borne trade.
,,	Diaz.	A Portuguese navigator of the 15th century. He was the first to round the Cape of Good Hope, and he discovered Algoa Bay.
,,	Vasco-da-Gama	Another Portuguese sailor, who discovered the sea route to India and reached Goa in 1498.
26.	Navigation.	The science of steering and controlling a ship by means of the compass and observation of the sun and stars.
,,	Carthage.	A short lived Empire on the north coast of Africa, which fell under the domination of Rome. Hannibal, Carthaginian King tried to stem the growing power of Rome, and in the historic march of his troops over the Alps nearly succeeded. He defeated the

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		Romans at the Battles of Lake Trasimene and Cannae (218 B.C,) But he was himself defeated at Zama and the Carthaginian Empire decayed.
,,	Venice and Genoa.	In the Middle Ages Itlay was composed of a number of independent city republics of which Venice and Genoa were the most important owing to their leadership in trade.
27.	Columbus.	Portuguese navigator who crossed the Atlantic under the patronage of Ferdinand and Isabella of Spain and so founded Spanish Empire.
28.	Magellan.	Portuguese navigator, who during the reign of Elizabeth was blown through the straits which divide the island of Tierra del Fuego from the mainland of S. America and which now bears his name. He continued his voyage westward, and was thus the first man to sail round the world.
28.	Frobisher and Davis	Adventurers and explorers who tried to find the N. W. passage as a new route to the East and have left their names in the geography of the northern seas.
,,	Hawkins.	John—a member of a famous family of seamen—was the first Englishman to deal in slaves, whom he captured on the west coast of Africa and sold to the Spanish in America.
,,	Raleigh	Explorer, adventurer and historian. He was the first English-

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		man to be seriously interested in colonization. He made two successful attempts to found the Colony of Virginia and to reach the city of Eldorado on the Orino-co, where he expected to find gold.
28.	Gilbert.	Explorer and sea man, rediscovered Newfoundland and brought back a ship-load of earth because he thought it contained gold. Was drowned at sea on one of his voyages (1583). (For a most interesting account of these men see Froude's "English Seamen of the Sixteenth Century").
,,	Mariner's compass.	A compass depending upon the magnetic attraction of the North Pole, which enables sailors to find their way across the seas when out of sight of land.
,,	Captain Cook.	(1728—1779). A famous English explorer. He did more than any other man to add to our knowledge of the Pacific and the Southern ocean. He was the first Englishman, to set foot on the continent of Australia, when he landed at Botany Bay ; and he explored the whole coast of Australia and New Zealand.
29.	"Queen Marry," "Normandie," and "Europa."	Three of the biggest liners on the Atlantic service. The "Queen Marry" and the "Normandie" are both over 70,000 tons ; and all three ships can cross from Europe to America in just over four days. " The Queen Marry"

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		is British, the "Normandie" is French, and the "Europa" is German.
29	Dhow.	A small sailing boat used by fishermen in the East.
,,	Tanker.	A ship used for carrying oil, and given its name because of the nature of its construction, which resembles a floating tank.
30.	Medieval times.	The period of European History from A. D. 800—1500, often also known as the Middle Ages.
,,	Armada.	The great Spanish fleet of 150 ships which attacked England in 1588, and was completely defeated. This defeat broke the power of Spain in Europe.
32.	American Civil War.	Fought between the Northern and the Southern States, mainly over the question of slavery. The North won, and slavery was abolished, but owing to the skill of President Abraham Lincoln the two halves remained united.
33.	Tramp.	The name often given to a slow ship built for carrying cargo, and moving from port to port.
34.	The Ark of Noah.	When the earth was destroyed by flood, two specimens of all living creatures on the earth were saved in this ark or large boat. The story forms part of the literature of the Jewish, Babylonian and Muslim religions.
36.	Gliding.	Travelling through the air in an aeroplane without an engine, which depends upon the currents of the air and winds.
38.	Biplane.	An aeroplane with two wings.

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		One with one wing is called a Monoplane.
39.	Bleriot.	A French airman who was the first to cross the English Channel in an aeroplane.
44.	Compositor.	The man in a printing press whose work is to set up or compose in type any piece of writing to be printed.
,,	Manuscript.	A piece of writing either written by hand, or typed, but not printed.
45.	Keyboard.	Rows of letters, as on a typewriter. When the key of a particular letter is pressed, that letter is assembled in the line to be cast.
46.	Cows are Milked.	By means of a machine worked by electricity. Cups are fitted to the teats of the cow, the current is switched on, and the milk begins to flow, as from a tap !
51.	Rowland Hill.	(1795—1879). Was a teacher until 1853. He was also one of the founders of a society for increasing General Knowledge. The uniform rate of postage, which he proposed, was introduced in 1840. He was knighted in 1860.
53.	Morse.	(1791—1872). He started life as a painter, and became at one time President of the National Acamedy of Design at New York. It was on a voyags in 1832, from Havre to New York, that he thought of a magnetic telegraph. By means of shorts dots and dashes, which represent letters of the alphabet, messages

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		can be sent over a wire. These dots and dashes are called the Morse Code.
53.	Lord Kelvin.	(1824—1907) Mathematician and physicist. He is regarded as one of the greatest scientific thinkers of the nineteenth century.
55.	Coral.	A soft rock, which is formed on the ocean-bed, by insects.
58.	Focussed.	Brought to a point. In a cinema the rays of light from the film are "focussed" on to the screen. Waves of sound can be focussed in the same way.
61.	James Watt.	(1736—1819) Was for long the mathematical instrument maker to the University of Glasgo. He had a very successful business career and made many useful inventions.
62.	Mangle.	The system of washing clothes in the West is entirely different from that in India. The clothes are not beaten against stones, but are washed in a basin or bath, and are then passed through a mangle, which is a machine having two wooden rollers which squeeze the water out of the wet clothes.
64.	Edition.	(1847—1933). American scientist and inventor. Improved the system of telegraphy; invented the gramophone, the electric motor, the electric bulb, the cinematograph, and the telephone. He made more useful inventions than any other one man.
66.	Stenographer.	One who is trained to take down the spoken word in a

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		shortened form of signs and then to write or type the original words again on paper.
68.	Kodak.	One of the most popular makes of camera, which was the first to be put on the market.
70.	Television.	A wonderful new invention so that we can see and hear people at a distance at the same time.
72.	Quarry.	A place from which rock and stone and marble are obtained, by breaking off pieces from a hillside or mountain.
73.	Egyptian Pyramids.	Famous tombs of the Egyptian Kings or Pharaohs, in the desert near Cairo. They are huge blocks of stone, built in the shape of a pyramid, and the tomb is in the middle. Many wonderful discoveries have been made from these tombs.
,,	Copper ore.	No metal is found in a pure state in the ground. They are all found in the form of ores, which are mixtures or compounds of the metal and other substances. The metal is generally obtained by heating the ore.
74.	Steel.	This is a form of iron, which has been specially heated and treated to make it stronger. This process is called tempering.
,,	Smelt.	The iron ore is melted and mixed with other substances such as coke and lime in huge blast furnaces. The pure iron is thus separated, and is then tempered to make steel.

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75.	Ventilators.	Small windows or openings high up in the walls of a house or room, to allow used air to escape, and fresh air to come in.
76.	Cranes.	Machines used for lifting very heavy weights by means of a long steel arm and steel ropes.
77.	Wind-mills,	Mills for grinding corn which are driven by four large arms. The wind moves these arms, and so drives the mill.
,,	Yachts	Small private sailing boats. There are also a few private steam yachts.
78.	Turbines.	A form of engine used in making electricity and in driving ships. Water of steam pushes against a series of projections or teeth on a wheel, and so makes it revolve. Turbines are used in the Hydroelectric schemes of India.
79.	Bye-products.	Substances which can be obtained from another substance by heating and purifying, as in the case of coal and oil.
,,	Sap.	The juice or life-blood of a tree. Rubber is obtained from the sap of the rubber tree.
,,	Insulator.	A substance along or through which electricity will not travel. On all the telegraph and electric supply poles, the wires are fixed to the poles by means of white insulators, so that the current will not run to the earth.
80.	Numb.	Cause it to lose all feeling. When climbing in the snow fingers and toes become numb from the

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	cold. Anaesthetics are used to numb the feelings of the whole body by means of sleep.
83. Alloys.	Metals composed of a compound of two or more metals.
84. Lodestone.	Iron or having magnetic properties,
98. Expectation of life.	The average length of life in a particular place or country.
100. Bacteria.	Germs or microbes.
101. Microscope.	Like a telescope, except that it is used for seeing very small things, like germs, close at hand, whereas a telescope is used for seeing very large things far away.
,, Pasteur Institute.	There are several institutes in India, *e.g.*, Kasauli and Patna. It is a great compliment to the memory of the great scientist that these institutes all over the world should be known by his name.
102. William Harvey.	(1578—1657). He was a celebrated doctor of his day, being Physician Royal to James I and Charles I.
,, Anatomy.	The science of the way in which the human body is made.
102. John Hunter.	(1728—1793) and his brother William, built lecture theatres, dissecting rooms, and museums at their own expense, in the hope of establishing medical practice on scientific lines.
103. Edward Jenner	(1749—1823). It was his ambition to spread vaccination from one human being to another, until it had become common over the whole world, and had exterminated small-pox.

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105.	Anaesthetics.	Special chemical used to put to sleep patients who are to undergo an operation.
,,	Lister.	(1827—1912). In addition to the introdction of his antisceptic surgery, which has revolutionized modern operations, he also made important discoveries regarding the coagulation of the blood, and inflammation.
107.	Sir Ronald Ross.	Started life in the Indian Medical Service. His famous discovery of the cause of malaria, was made at Banglore. Later he became Direcotor of the School of Tropical Diseases in London.
108.	The Crimean War.	(1952—54). Fought between Russia and an alliance of European powers. It was fought in the snow and cold of the Russian winter.
,,	Florence Nightingale.	(1820—1910). She devoted her attention mainly to the removal of bad sanitary arrangements in military hospitals. On her return to England a fund was collected to enable her to start a school for the trainning of nurses, and for the opening of Hospitals in England.
114.	Cathedrals.	The chief Christian Church in any Province or country, is called a Cathedral.
,,	Fatehpur Sikri.	A wonderful city or red-sandstone built by Akbar about 25 miles outside the walls of Agra, and still one of the most beautiful examples of Moghul architecture.
116.	Miniatures.	Very small pictures painted in very great detail.

117.	Sculpture.	The art of carving the human figures, animals etc., in stone.
,,	Sanchi.	The site of Buddhist monasteries and Stups in Bhopal State. The history of Buddha has been told in a series of wonderful stone carvings, and is one of the mast beautiful and interesting of all historical places in India.
120.	Astronomy.	The science of observing the stars and learning about the Heavens and the laws of the Universe.
121.	Milky Way.	The broad band of stars which stretches across the sky, composed of millions and millions of stars so that it looks almost white.
,,	Insignificance.	Unimportance, or smallness.
122.	Seismograph.	An instrument for recording whenever the earth is shaken by an earthquake. The instrument is so delicate that it can record an earthquake which occurs many thousands of miles away. Another word for 'quake' is tremor.
124.	Sir Francis Younghusband.	Traveller, explorer and mountaineer. He had considerable experience of climbing in the Himalayas.

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